University of Alberta

INCORPORATING PERCEPTIONS OF SITE QUALITY IN A DISCRETE CHOICE ANALYSIS

by

© KRISTINE NOVENA McLEOD

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE**

in

FOREST ECONOMICS

Department of Rural Economy

Edmonton, Alberta

Spring 1995

National Library
of Canada

Acquisitions and
Bibliographic Services Branch

395 Wellington Street
Ottawa, Ontario
K1A 0N4

Bibliothèque nationale
du Canada

Direction des acquisitions et
des services bibliographiques

395, rue Wellington
Ottawa (Ontario)
K1A 0N4

Your file Votre référence

Our file Notre référence

THE AUTHOR HAS GRANTED AN IRREVOCABLE NON-EXCLUSIVE LICENCE ALLOWING THE NATIONAL LIBRARY OF CANADA TO REPRODUCE, LOAN, DISTRIBUTE OR SELL COPIES OF HIS/HER THESIS BY ANY MEANS AND IN ANY FORM OR FORMAT, MAKING THIS THESIS AVAILABLE TO INTERESTED PERSONS.

THE AUTHOR RETAINS OWNERSHIP OF THE COPYRIGHT IN HIS/HER THESIS. NEITHER THE THESIS NOR SUBSTANTIAL EXTRACTS FROM IT MAY BE PRINTED OR OTHERWISE REPRODUCED WITHOUT HIS/HER PERMISSION.

L'AUTEUR A ACCORDE UNE LICENCE IRREVOCABLE ET NON EXCLUSIVE PERMETTANT A LA BIBLIOTHEQUE NATIONALE DU CANADA DE REPRODUIRE, PRETER, DISTRIBUER OU VENDRE DES COPIES DE SA THESE DE QUELQUE MANIERE ET SOUS QUELQUE FORME QUE CE SOIT POUR METTRE DES EXEMPLAIRES DE CETTE THESE A LA DISPOSITION DES PERSONNE INTERESSEES.

L'AUTEUR CONSERVE LA PROPRIETE DU DROIT D'AUTEUR QUI PROTEGE SA THESE. NI LA THESE NI DES EXTRAITS SUBSTANTIELS DE CELLE-CI NE DOIVENT ETRE IMPRIMES OU AUTREMENT REPRODUITS SANS SON AUTORISATION.

ISBN 0-612-01635-8

Canada

University of Alberta

Library Release Form

Name of Author: Kristine Novena McLeod

Title of Thesis: Incorporating Perceptions Of Site Quality In A Discrete Choice Analysis

Degree: Master of Science (Forest Economics)

Year this Degree Granted: 1995

Permission is hereby granted to the University of Alberta Library to reproduce single copies of this thesis and to lend or sell copies for private, scholarly or scientific research purposes only.

The author reserves all other publication and other rights in association with the copyright in the thesis, and except as hereinbefore provided, neither the thesis nor any substantial portion thereof may be printed or otherwise reproduced in any material form whatever without the author's prior written permission.

KN McLeod

#118 - 2460 156 Street
White Rock, B.C. V4P 1C8

Jan. 31, 1995

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled **Incorporating Perceptions of Site Quality in a Discrete Choice Analysis** submitted by **Kristine Novena McLeod** in partial fulfillment of the requirements for the degree of **Master of Science** in **Forest Economics**.

Wiktor L. Adamowicz, Supervisor

William E. Phillips, Committee Member

Paul Woodard, Committee Member

ABSTRACT

Incorporating environmental quality into discrete choice travel cost models is an increasingly popular method. A study was undertaken in the winter of 1992 and early 1993, where moose hunters from 5 towns in west-central Alberta were surveyed. The information collected was then used to develop a discrete choice random utility model to predict site choice and examine resulting welfare estimates based on possible management policies.

Two models incorporating perceived site attributes and two models incorporating objective site attributes were estimated. Each set of models was examined under a full choice set scenario, including all 14 sites, and a reduced choice set scenario, where the choice set varied by individual based on perceptions of site attributes. Incorporating perceptions of site quality and allowing for a reduced choice set provide insight into behavioural linkages of site choice.

In addition to examining the general statistics associated with model estimation, the models were evaluated in terms of their ability to predict choices in a holdout sample, suggested by Horowitz and Louviere (1994). Also, Goodness of Fit measures specific to choice modeling were compared across models. Model performance tests indicated different preferred models based on the type and depth of statistical testing. Under simple tests, the full choice set objective measure model was identified as the stronger model, however, under the out of sample scenario, the reduced choice set perceived measure model was identified as the stronger model. Thus, it is important to choose the type and depth of statistical testing specific to the models estimated.

ACKNOWLEDEGMENT

There are many who deserve recognition for helping me at some point during my post secondary studies. To begin, I would like to thank the Canadian Forest Service (CFS) for funding this project, and those individuals who were included in the project. Also, many thanks to the wildlife officers and biologists from the towns surveyed as they provided important information for the study analysis.

Another individual who deserves a special thanks is my supervisor, Vic Adamowicz. In addition to being an excellent teacher and advisor, he always provided direction, positive feedback and encouragement whenever questions or concerns arose. Thanks also to my committee members for their insightful comments and to Peter Boxall of CFS who was always willing to help. Thanks to the staff and my friends of the department of Rural Economy for all of your help and laughter. And, to Tamantha Peters for the "e-mail" encouragement and friendship.

My final thank-you is reserved for my family, who have always supported me in my endeavors and believed that I could accomplish this degree, thanks so very much. Lastly, my husband Andrew, you have had confidence in me from the start and were always there when I needed support or understanding, thank you for being by my side.

TABLE OF CONTENTS

CHAPTER 1 - INTRODUCTION 1

INTRODUCTION 1

RESOURCE VALUATION 2

ATTRIBUTE DATA 4

PRESENTATION OF THIS STUDY 6

CHAPTER 2 - BACKGROUND: RESOURCE VALUATION 8

INTRODUCTION 8

NONMARKET VALUES 8

RESOURCE VALUATION 9
- Assessing Environmental Damages 10
- Natural Resource Accounting 10
- Project Evaluation 11
- Policy Development and Regulation Standards 11

MEASURING THE VALUE OF RECREATION 13
- Introduction 13
- Contingent Valuation 13
- Travel Cost Methodology 14
- Summary 17

CHAPTER 3 - THEORETICAL FRAMEWORK 18

ECONOMIC AND ECONOMETRIC ASSUMPTIONS 18
- Introduction 18
- Economic Theory 18
- Discrete Choice Theory 20
- Random Utility Theory 21
- Multinomial Choice 23
- Estimation 26

THE THEORY OF WELFARE MEASUREMENT 28

MEASURING ENVIRONMENTAL ATTRIBUTES 31
  Information, Attitudes, and Behaviour 31
  Objective Attribute Data (expert opinion) 33
  Perceived Attribute Data (subjective opinion) 34
  Summary 36

CHAPTER 4 - THE DATA SET AND MODEL DESCRIPTION 38

INTRODUCTION 38

QUALITY DATA 40

DETERMINING THE CHOICE SET 47

MODEL DESCRIPTION 48

SUMMARY 49

CHAPTER 5 - ESTIMATION RESULTS AND POLICY SIMULATIONS 50

INTRODUCTION 50

ESTIMATION RESULTS 50

FULL CHOICE SET MODELS 55

REDUCED CHOICE SET MODELS 58

PREDICTIVE ABILITY 61
  Wald Test 61
  Prediction 62
  Out of Sample Test 66

WELFARE ANALYSIS 73
  Simulating Policy Scenarios 73

SUMMARY 77

CHAPTER 6 - CONCLUSION 79

INTRODUCTION 79

STUDY FINDINGS.. 79

CURRENT ISSUES..81

DIRECTIONS FOR FUTURE RESEARCH 83
    Opportunity Cost of Time 83
    Incorporating Demographic Variables... 84
    Modeling Techniques.. 85
    Limitations... 86

CONCLUDING REMARKS... 87

BIBLIOGRAPHY 89

APPENDIX 1 94

APPENDIX 2... 104

APPENDIX 3... 106

APPENDIX 4... 109

APPENDIX 5..113

APPENDIX 6..118

LIST OF TABLES

Table 4-1: Variable Definitions as Explained in the Survey and Initial Rating Values 41

Table 4-2: Effects Coding for Moose Population Variable.... 44

Table 4-3: Transformed Variables Included in the Objective Measures Model 45

Table 4-4: Transformed Variables Included in the Perceived Measures Model 46

Table 5-1: Model 1 - Full Choice Set Objective Measures....51

Table 5-2: Model 2 - Full Choice Set Perceived Measures.... 52

Table 5-3: Model 3 - Reduced Choice Set Objective Measures.... 53

Table 5-4: Model 3 - Reduced Choice Set Perceived Measures 54

Table 5-5: Distribution of Predicted and Actual Number of Trips Full Choice Set Models 63

Table 5-6: Distribution of Predicted and Actual Number of Trips Reduced Choice Set Models 64

Table 5-7: Prediction Success Table - Full Choice Set Objective Measures....114

Table 5-8: Prediction Success Table - Full Choice Set Perceived Measures 115

Table 5-9: Prediction Success Table - Reduced Choice Set Objective Measures....116

Table 5-10: Prediction Success Table - Reduced Choice Set
Perceived Measures 117

Table 5-11: Out of Sample Distribution of Predicted and Actual
Number of Trips for the Full Choice Set.. 68

Table 5-12: Out of Sample Distribution of Predicted and Actual
Number of Trips for the Reduced Choice Set 69

Table 5-13: Out of Sample Prediction Success Table
Full Choice Set Objective Measures..119

Table 5-14: Out of Sample Prediction Success Table
Full Choice Set Perceived Measures 120

Table 5-15: Out of Sample Prediction Success Table
Reduced Choice Set Objective Measures 121

Table 5-16: Out of Sample Prediction Success
Reduced Choice Set Perceived Measures.................................. 122

Table 5-17: Hunter's Highest Utility as a Proxy for Predicted
Site Choice - Full Choice Set...71

Table 5-18: Hunter's Highest Utility as a Proxy for Predicted
Site Choice - Reduced Choice Set.. 72

Table 5-19: Welfare Measures.. 74

LIST OF FIGURES

Figure 1: Map of Study Area Wildlife Management Units 103

CHAPTER 1 - INTRODUCTION

INTRODUCTION

Increasingly, public and private agencies are acknowledging the multiple uses and at times conflicting uses of our natural resources. Forests are one such resource where controversy exists. The chief issue of concern for this study is forestry operations. Peter Pearse (1990) states that

> "often, a forest can generate two or more kinds of benefit(s) simultaneously, or sequentially--such as industrial timber, recreation, and livestock forage--in which case someone must choose the preferred combination and pattern of uses" (Pearse, 1990 p.4).

Decisions such as those mentioned above require considerable examination of the market and nonmarket values associated with the various resource-use patterns. In the past, forest resources were valued for the market benefits which were derived through extraction or processing. Rarely, consequences to the environment were considered. However, effective management of the outdoors requires all benefits and costs to be examined.

In terms of benefits, this includes market values - stumpage or wood product sales, campsite revenue, hydro-electric or oil and gas developments, and nonmarket values - the hunting or fishing experiences, scenic views, water quality. With regard to costs, there are market costs - the costs associated with resource extraction, bringing the product to market, campsite development and upkeep as well as nonmarket costs - soil erosion, habitat loss, decrease in wildlife populations. Nonmarket valuation techniques are increasingly being used in an effort to better estimate the value of the resources in question. To this end, researchers continue to explore methods of valuing the natural resources of our country to better equip themselves with information to make land-use decisions.

Forest Managers are faced with multiple use decisions. Incorporating nonmarket values in decision-making is changing the direction of forest management. One example of a highly publicized nonmarket issue in the Pacific Northwest is the preservation of the Northern Spotted Owl. It has been reported that this endangered species requires a certain amount of old growth forest for survival (McComb *et al.*, 1993). A continued demand for timber and related products had forest companies cutting in these old growth areas. Environmental management initiatives and policy caused a reduction of annual allowable cuts in this area to enhance and maintain current habitat for the Spotted Owl.

Forest management decisions must address nonmarket issues. This feat is accomplished by analyzing how nonmarket values are affected by various forest-use decisions. This thesis will examine one of these non-market valuation techniques and test several assumptions associated with the approach.

RESOURCE VALUATION

The economic tools available to determine the benefits and costs of proposed forestry projects are varied and each has strengths and weaknesses as well as advocates and cynics (Fletcher *et al*, 1990; Hausman, 1993). Evaluating the economic effects resulting from changes in environmental attributes is important when determining the value of site attributes for the recreational user, as a decision-making tool for evaluating policy proposals, and to effectively manage our natural resources.

Environmental awareness and concern for the maintenance and/or improvement in resource quality is one of the motivations behind the inclusion of nonmarket values in Benefit-Cost (B-C) analysis. Nonmarket goods such as hiking trails, wildlife populations, scenic views, or clean streams, are not typically traded in the marketplace but can and should be valued. Using B-C analysis as a policy tool relies upon theoretically sound methods of determining values for these nonmarket goods.

The Travel Cost Method is one approach used to measure the net economic benefits of outdoor recreation activities. This indirect approach determines the value of a site due to a quality, quantity or price change where the distance (or travel cost) is a proxy for price and varies over individuals. By varying the price, quantity or quality of a site, rates of visitation are altered and a demand curve emerges. From this development, the consumer surplus is identified as the area under the demand curve and represents the value of the site. Comparing the difference in the area under the curve before and after a change of price or quality represents the cost/benefit due to that change. Thus nonmarket values can be included in B-C studies. Interest in improving techniques and continued research has led to adaptations of this method and particularly an interest in examining the items that influence a recreation user's site choice.

An extension of the travel cost model is the Random Utility Model (RUM) which is based on utility theory and is commonly used to model the probabilistic nature of site choice behaviour (Ben-Akiva and Lerman, 1985). Each individual's "utilities" are seen as random variables and this suggests that the researcher observes a recreationist's choice without complete, certain information about the individual's true utility function. The RUM concentrates on individual decision-making so that an individual chooses the site which yields the highest utility. One characteristic of these types of models is the inclusion of a choice set, or set of potential recreation sites from which an individual will choose. A further consideration for these models is the nature of the attribute (site quality) data.

Adopting the discrete choice (DC) framework is one way of modeling site choice. Rather than deriving demand functions, choice theory deals directly with utility functions, thus is easily adapted to the random utility framework. The discrete choice approach models the recreationist's site choice decision for each recreational trip as actual trip behaviour is observed (from responses to the survey questionnaire). The DC framework is useful when examining attribute changes at recreation sites as each site is modeled as a bundle of attributes. Also, the DC model is characterized by the dependent variable, which assumes that only one site (or alternative) is chosen to visit. This method may provide insight into trip choice decisions for improving modeling techniques.

ATTRIBUTE DATA

In an effort to better understand the nature of site choice behaviour, fields such as economics, geography, business, and social-psychology offer insight into ways that travel cost models may be improved. One way in which these models may be extended is by incorporating user perceptions of the site attributes. This step would allow the researcher to examine further the reasons or motivation behind an individual's site choice decision and provide a means to examine policy proposals based on perceptions of site quality.

One method of enhancing travel cost models is to include measures of site quality. Recent studies include only objective or expert measures of site quality when incorporating the attributes of study sites into model analysis (Cameron 1988, Peters 1993). Using perceptions of attribute levels is relatively new and requires detailed surveys of individuals. Therefore with this information welfare estimates based on perceived quality changes can be examined. The recreationist must be aware of the change in quality otherwise his/her behaviour will not be altered and the change is in effect irrelevant.

How should perceptions be included in these types of analyses? If hunters do not have perceptions of quality at a certain site, should that site be included in the choice set? Even if someone is aware of a site, they may not have any idea about the site's attributes. These issues are explored in this study.

This concept of incorporating perceptions is addressed in the modeling portion of the analysis. Recreational moose hunter's site choice is examined using a random utility model. Choices made by recreational moose hunters are from a set of fourteen possible hunting sites. Two simple random utility models are developed including all fourteen sites in the hunter's choice set. One models the expert (objective) quality attribute measures and the other models the hunters perceived quality attribute measures. Then, a reduced choice set model is developed which includes only those sites which a hunter has reported an opinion for all five attributes.[1] Four models result and are compared based on perceived and objective quality attribute measures for both the full and reduced choice set scenarios.

The research contained herein is based on a survey of 271 general moose hunting license holders from five towns in west-central Alberta. This area of Alberta is unique as many activities co-exist, such as hunting, camping, wildlife viewing, snowmobiling, logging, oil & gas, mining, hiking, horseback riding, and others. The moose hunting survey resulted in a variety of data which can be used to investigate the benefits and costs of possible forest-use decisions, wildlife management initiatives or other policy objectives which would particularly affect recreational moose hunters in this area.

The scope of this thesis includes examination of the economic impacts resulting from changes in environmental quality, not the impacts of altering the state of the environment. Specifically, the objective of this thesis is to examine ways in which the RUM can be enhanced to model the reasons that individuals choose certain sites for outdoor recreation, observe how changes in site attributes or perceptions of attributes affect a moose hunter's site choice decision, determine the benefit or cost of these quality changes, and examine how this is useful for environmental policy and resource planning.

PRESENTATION OF THIS STUDY

The rest of this thesis is organized in the following way. Chapter 2 includes a discussion of nonmarket values, reasons for resource valuation and valuation techniques. Chapter 3 outlines the economic assumptions and econometric theory for this analysis, including a section on welfare theory which discusses the relevant theory of benefit measurement, and ends with a description of ways to incorporate environmental attributes. Chapter 4 describes the data collection method and the data set used in this research. Also, the necessary transformations of this data for further detailed analysis are reported along with the model development and final model description. Chapter 5 presents the estimation results, focusing on the econometric techniques employed, relevant statistics and model comparison. This section examines the welfare estimates associated with hypothetical attribute quality changes and their interpretation. Policy analysis will be explored with regard to moose hunting and environmental site quality. Lastly, Chapter 6 highlights the study findings, the implications of the results, and directions for future research.

---

[1] See the opinion table from the AB Moose Hunting Study questionnaire located in Appendix 1. Three sections of the survey are included in this Appendix.

CHAPTER 2 - BACKGROUND: RESOURCE VALUATION

INTRODUCTION

The concern for the environment has caused resource owners and managers to value natural resources for all of the varied outputs that they produce. These outputs include logging, mineral extraction, wildlife habitat, old growth forests, water quality, scenic views and others. The first two outputs are relatively easily valued in the marketplace as they are typically bought and sold, but the latter goods are not. However, society places a value on these nonmarket resources, and it is necessary from a social decision-making standpoint to evaluate the effects of a proposed action to alter a site before such a project is undertaken. This action includes the incorporation of market and nonmarket values into the analysis. This chapter discusses the definitions of nonmarket values, resource valuation, and recreation site valuation techniques.

NONMARKET VALUES

Nonmarket values are associated with goods and services that are not typically bought and sold in the marketplace. These values represent the environment in a relatively new way. For example, should a value exist for an improvement in moose habitat or an increase in moose populations? In order to address these types of questions, definitions of the types of nonmarket values frequently used and the methods of obtaining these values are required.

Some resource valuation methods measure use value which "refers to the value an individual holds for participating in an activity" (Adamowicz 1991, p4). There are two categories of use value, consumptive, which refers to the value associated with an activity which may alter the amount of the resource, such as hunting or fishing, and, non-consumptive, which refers to a value associated with an activity not altering the state or condition of a specific natural resource, such as scenic photography or bird-watching.

Non-Use or Passive Use value refers to the value individuals place on the existence of a resource e.g. a bird sanctuary or old growth forest (existence value). A similar concept, bequest value, is the value individuals place on the resource to be left for future generations to enjoy. Non-use values are commanding more attention in the literature and current research is engaged in an effort to find consistent ways of measuring these values and determining when they are appropriate for use in Benefit-Cost or non-market analyses.

Including nonmarket values has not been a priority for many resource owners/extractors until fairly recently. In the past, there were neither incentives from government to examine nonmarket benefits nor pressure from public or private interest groups. There are several reasons why the valuation of nonmarket goods is increasing in importance and these are described below.

RESOURCE VALUATION

Resource valuation is required more frequently for a number of reasons including: a) assessing environmental damages; b) natural resource accounting; c) project evaluation; d) regulation standards and policy development.

Assessing Environmental Damages

Unfortunately there are increasing instances of environmental damage due to accidents and error. The most notable cases in the past decade concern oil spills, contamination of ground water and soil, as well as air, stream, and lake pollution. "Damage assessment is undertaken to estimate how the value of one or more natural assets injured by hazardous waste or oil has changed due to those injuries" (Kopp & Smith 1993, p.130). In an oil spill for example, the oil lost and boat damages are clear costs, however the wildlife which is destroyed or crippled and the contaminated beaches, shoreline, and changes in water quality are not usually included in overall costs. In order to fully assess the damage, both market and nonmarket values must be determined.

> Proceeding with a damage assessment involves two main tasks. "The first task is to estimate the value a typical person places on the resource's services under different conditions of perceived injuries, while the second task is to determine how many people hold this value" (Kopp & Smith 1993 p.130).

Market values often do not exist for wildlife or clean beaches. Therefore, nonmarket valuation is one way to address and value these resources.

Natural Resource Accounting

Natural Resource Accounting (NRA) is a relatively new area of resource valuation. Primarily NRA is a method of valuing a country's natural resources for use in their overall national accounting system. This is undertaken in an effort to track a country's use of their natural capital and simply to value these environmental assets and include them in the overall balance sheet. Much of the earlier work in this field focuses on developing countries (Repetto 1993, El Serafy and Lutz 1989). Natural Resource Accounts require both market and nonmarket values to present a comprehensive image of natural capital accounts.

Project Evaluation

Resource valuation for Benefit-Cost (B-C) Analysis is perhaps the most common and widely known use for nonmarket values. It is important to assess the benefits and costs of a project before it is undertaken. Should land zoned agricultural be turned into a golf course or parking lot? What are the implications of building or upgrading a dam? Essentially the questions are: What are the benefits, what are the costs and to whom do they accrue? The examples mentioned above require that the market and nonmarket benefits associated with the area be determined. Once the project is outlined and the market and nonmarket goods specified, then an evaluation of the benefits and costs of implementing the project is undertaken.

Policy Development and Regulation Standards

Resource values provide information for setting policy objectives and making regulatory decisions. Comparing the marginal benefits and marginal costs of regulation options enables standards to be set from which environmental policy can be developed (Freeman *et al.* 1973). Alternate scenarios can be examined and the distribution of the benefits and costs analyzed to determine if distribution is equitable.

As new techniques are employed and deemed acceptable at valuing the natural resources, public agencies will need to respond by examining past policies and regulations to reflect these changes. Specifically, to evaluate the decision-making process with regard to the environment and examine the link between national and regional economic and social objectives. Nonmarket valuation techniques can assist with this process. What follows is a discussion of the methods most frequently used to value non-market goods. These will be discussed within the context of the Alberta Moose Hunting Study.

Managing the forests requires more than calculating how many trees can be cut. The forest contains more than market benefits from extraction. They hold multiple uses, and it is possible to manage forests for these multiple uses. In this study, one particular non-timber value is examined, the value of recreational moose hunting.

Forest companies may be most interested in timber harvests to maximize profit, however, moose hunters are concerned about the impact of cutting techniques on moose habitat and the access routes which are developed. Moose hunting is not the only activity coexisting in this area. Camping, snowmobiling, nature walking, bird watching and others are also present. Nonmarket valuation techniques can be utilized to examine these types of issues, but in this study we focus on moose hunting and examine the assumptions associated with the valuation of recreational hunting.

MEASURING THE VALUE OF RECREATION

Introduction

The purpose of this section is to briefly discuss the literature on the use of the Contingent Valuation Method (CVM) and the Travel Cost Model (TCM) for measuring the value of recreation. Recreation demand and resource valuation research has followed a natural progression over time by incorporating new variables and improving existing methods. These studies are undertaken to value the natural resources, in particular nonmarket goods, which are not typically traded in the marketplace. It is necessary to examine the formulation and assumptions of the methods to determine the appropriate model for analysis.

Outdoor recreation is one activity that has sparked an increased interest in enhancing the current site valuation techniques. The Travel Cost Model (TCM), an indirect method, and the Contingent Valuation Method (CVM) a direct method, are two common approaches used in measuring net economic benefits of changes in resource quality at outdoor recreation sites.

Contingent Valuation

The Contingent Valuation Method is a popular method used to determine nonmarket values. Typically, people are asked "how much are you willing to pay" for the maintenance (preservation or improvement) of a resource, wildlife species, environmental program or geo-physical feature. The goal of this method is to elicit people's preferences for the natural resource in question by directly asking them for a value, or by asking them to accept or reject a (bid) value. The former is called an open-ended approach and the latter is called "closed-ended." Generally, surveys are conducted to obtain this information.

There are many different forms of the hypothetical questions which are asked, and as in most studies, the responses are only as good as the survey. In order to ensure reliable answers, careful attention must be paid to the overall survey design, question design, word choice, elimination of possible bias, and the inclusion of relevant and clear background information.

One of the main drawbacks to using the CVM is the fact that researchers are creating hypothetical situations via the survey, and not observing actual behaviour as in the TCM. The CVM can be used in discrete choice analyses but is not the chosen method for the ensuing research, thus detailed strengths and weaknesses of this approach are not dealt with here. For further information on this topic see: Hausman (1993) or Mitchell and Carson (1989).

Travel Cost Methodology

One approach which has commanded a great deal of attention in the past 20 years is the Travel Cost Model . This method was initially proposed by Hotelling in 1947 (as noted in Prewitt, 1949), and later developed more formally by Clawson and Knetsch (1966). The TCM measures nonmarket values of recreation sites by examining a recreationist's actual behaviour or trips to a particular site. Stated simply, the travel cost incurred to get to the site is considered a proxy for price which is then used in conjunction with the number of visits to obtain a demand curve for the site. Therefore, visits to a site are a function of travels costs, prices, attribute quality, and socio-economic variables

Adaptations to the simple TCM resulted from the need for better methods of economic valuation, for use in policy development, project planning, and efficient resource allocation. The travel cost methodology can be separated into the following categories: zonal and individual travel cost models, generalized travel cost model , hedonic travel cost model, and discrete choice models.

The zonal travel cost model examines the demand for the site by individuals residing in zone z, using the total number of visits from zone z, whereas the individual technique uses individual visits not grouped by zone of origin. Fletcher *et al.* (1990) discuss the problems surrounding estimation of zonal travel cost models and in particular state that individual data are preferred. This data preference is noted because individual travel cost models can be estimated which are consistent with utility theory, produce efficient estimates, and that theoretically acceptable demand aggregation and calculation of welfare measures are possible.

The generalized travel cost model utilizes a system of demand equations from which the estimated coefficients are regressed on a vector of quality attributes (Smith and Desvouges 1986). The parameters of the travel cost demand function vary systematically with differences in quality attributes across sites.

The Hedonic approach defines residence zones as in the earlier zonal travel cost model, treats each site as a bundle of attributes, and is completed via a two stage process. First, for each zone, an individual's costs of visiting a site are regressed on the site attributes. Taking the partial derivative of this function with respect to each attribute yields an hedonic cost or price function for that attribute. Next, the demand for each site attribute is estimated by regressing each hedonic price on the attributes of the site. A system of demand equations for the attributes of each site results. Thus "the demand function for a characteristic is assumed to reflect the marginal willingness to pay per recreation day for an increase in the quality of the characteristic" (Bockstael *et al.* 1987, p.954).[2]

The above mentioned variations of the simple TCM are grounded in the assumption that the demand for a site is a function of travel costs. However, they do not have the capacity to fully address the issues of substitute sites, zero choices of certain sites, or the incorporation of a random component in the individual's utility function (Smith 1993, Fletcher et. al. 1990).

The discrete choice random utility framework allows for the examination of site attributes and substitute sites. The recreationist chooses to visit one site from a set of possible sites. The random utility approach is a useful tool for evaluating nonmarket implications as it examines actual trip behaviour. These models are based on a well defined theoretical foundation of utility maximization subject to a budget constraint.

The utility framework enables the individual to choose the site which provides the greatest utility, or satisfaction, by ranking the attributes and thus the site itself. The probabilistic nature of site choice is easily modeled within this framework along with the calculation of welfare measures. This approach provides resource managers with a tool to put values on typically unpriced goods. Further, this method allows the prediction of an individual's site choice decision when a resource attribute is changed.

---

[2] A more recent recreation example is Englin and Mendelsohn (1991).

Because this study plans to address the underlying nature of site choice behaviour by incorporating perceptions of site quality, the random utility framework will be used and is derived more completely in the following chapter.

SUMMARY

This chapter discussed a number of issues including nonmarket values, resource valuation, and valuation techniques. This brief overview of the travel cost methodology displays various modifications to the simple TCM. However, what has been neglected in the discussion is a snapshot of some current topics covered in this literature. Researchers are looking to incorporate other fields such as geography, business, and social-psychology with the traditional economic recreation framework to better examine the underlying decision-making process of recreationists, to predict how individuals will react to changes in site quality, and to better inform the public about available sites. Specific topics and adaptations will be discussed later in this thesis. The following chapter outlines the theoretical foundation and the incorporation of environmental attribute data.

CHAPTER 3 - THEORETICAL FRAMEWORK

ECONOMIC AND ECONOMETRIC ASSUMPTIONS

Introduction

It is important to outline the fundamental assumptions of the economic and econometric theory which characterizes the following analysis. Before one can undertake B-C analysis incorporating econometric methods, the foundation must be clear. Because this analysis focuses on individual choice behaviour, modeled within the random utility framework, a natural progression leading to this technique is presented.

The format for this chapter consists of economic and econometric theory. This description is followed by a brief explanation of the statistical estimation method, which provides the necessary tools to analyze choice data. The following section contains an explanation of the theory of benefit measurement and the welfare (compensating variation) formula. The final section addresses the role of environmental attributes in choice based modeling and the nature of the data for this extension.

Economic Theory[3]

In examining the demand for recreation sites, one must introduce the underlying preference - utility - demand framework to describe and model the choices made by the recreationist. Economic theory assumes that individuals employ a preference ordering over consumption bundles following the axioms of consumer choice, and this preference relation is reflected in the individual's utility function. A person maximizes utility subject to one or more constraints from which demand equations are derived.

---

[3] This section closely follows discussions in Gravelle and Rees (1992) pages 68-78, 111-114, Deaton and Muellbauer (1991) pages 26-30, and Ben-Akiva and Lerman (1985) pages 39-43.

The "theory of the consumer" underlies the concepts of individual choice behaviour. Gravelle and Rees (1992) outline three specific steps toward analyzing the consumer's optimal choice: i) define the properties of consumer preferences; ii) define the set of possible consumption bundles; and iii) using the above information, determine the characteristics of a consumer's optimal choice. The axioms of choice define the properties of consumer preferences for ranking consumption bundles. The consumption decision is based on a consumer maximizing their utility *u,* subject to a budget constraint and is expressed as

$$\max_{q_1,\dots,q_N} \quad u\left(q_1,\dots,q_N\right) \tag{1}$$

$$\begin{aligned} s.t. \quad & (i) \ \sum p_n q_n \leq M \\ & (ii) \ q_N \geq 0 \quad (n = 1,\dots,N) \end{aligned}$$

where p = prices that consumer faces
q = consumption bundle
M = consumer's money income

The resulting first order conditions from this maximization problem can be solved for the Marshallian demand functions for q_N (given prices and income). Taking these functions and substituting them into the utility function yields the indirect utility function. The indirect utility function allows for the examination of how price or income changes affect the consumer's utility. With the underlying economic assumptions defined, what is required next is a link between the consumer or recreation user, site choice and travel cost theory.

Discrete Choice Theory[4]

Having outlined the importance of the utility function, and the basic travel cost model, the discussion now turns to the concept of discrete choice. The nature of discrete choice does not permit the common maximization techniques (mentioned above) to derive demand functions. Discrete choice means that a consumer is faced with a set number of alternatives and can choose only one. Therefore discrete choice theory deviates slightly from the consumer theory described above.

The discrete choice situation is defined generally by denoting a set of all possible recreation sites = C. However, a consumer, n, may not face all of these alternatives. Constraints on consumers such as knowledge of existing sites or preferences for certain areas reduces their individual choice set of alternatives to C_n, where $C_n \in C$. A utility, U, is defined for each individual for each alternative, i, as

$$U_{in}, \; i \in C_n \tag{2}$$

where alternative i (defined above) is chosen by individual n if

$$U_{in} > U_{jn}, \qquad \forall \; j \neq i, \; j \in C_n . \tag{3}$$

---

[4] The next three sections closely follow descriptions in Ben-Akiva and Lerman (1985) pages 44-66, 100-111,118,119.

Adapting the concept of indirect utility, attributes of the sites are expressed as a vector of values z_{in} (including price or travel cost as an attribute of each site), and socioeconomic characteristics of individual n are expressed as S_n. For individual n and alternative (site) i, the utility function is

$$U_{in} = U(z_{in}, S_n) \tag{4}$$

Discrete choice theory provides the background for choice based analysis. Introducing a probabilistic component through model specification allows the choice of a site to be modeled as the probability of choosing that site and is called the random utility approach.

Random Utility Theory

One specific type of discrete choice model is called a random utility model (RUM). The main assumptions upon which this model relies are that the trips are taken independently and that trip decisions are made one at a time (Fletcher *et al.* 1990).

Adopting the random utility approach implies that the indirect utilities are assumed to be random variables. This randomness can be described as observational errors on the part of the analyst. Because we are dealing with utility and choice behaviour, we infer an individual's utility from observing their choices. However, the observer does not know for certain the exact utilities (thus the random specification). In this way, the random utility approach accounts for the uncertainty that the researcher faces in modeling the reason that a recreational user chooses a particular site.

In this framework, the probability P, of choosing an alternative i, is the probability that the utility associated with choice i is greater than or equal to the utilities of all other possible alternatives in the choice set. This is expressed as:

$$P\left(i \mid C_n\right) = Pr\left[U_{in} \geq U_{jn}, \ \forall \ j \in C_n\right]. \tag{5}$$

A general expression composed of an objective and random part defines the random utility of an alternative as

$$U_{in} = V\left(z_{in}, S_{in}\right) + \varepsilon\left(z_{in}, S_{in}\right) = V_{in} + \varepsilon_{in} \tag{6}$$

where: V is the observable part of utility
z_{in} is a vector of attributes for alternative i influencing choice of person n
S_{in} are socio-economic characteristics for individual n
ε is an unobservable (random) element

With ε representing the stochastic component of choice behaviour, the equation can be rewritten in terms of probability as

$$P\left(i \mid C_n\right) = Pr\left[V_{in} + \varepsilon_{in} \geq V_{jn} + \varepsilon_{jn}, \ \forall \ j \in C_n\right]. \tag{7}$$

For these models, the functional form of the utility function and the error terms must be specified so that well defined properties may be assumed. One approach is to specify the functional form of the observable component of the indirect utility function as linear in parameters. A linear functional form is simple and is chosen frequently in these types of analyses. This choice results in the following representation of the indirect utility function

$$V_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_n x_n \tag{8}$$

or compactly in matrix form as

$$V_{in} = \beta' x_{in} \tag{9}$$

where: V_{in} is the estimated indirect utility
ß ' is a vector of estimated parameters
x_{in} is a vector of attributes for the alternatives

Multinomial Choice

Multinomial Choice Models are characterized by a choice set containing more than two alternatives. A generalized form of Equation 6 can be expressed as the probability that individual *n*, chooses alternative *i* (where Pr = probability)

$$\begin{aligned} P_n(i) &= Pr\left(U_{in} > U_{jn},\ \forall\ j \in C_n,\ j \neq i\right) \\ &= Pr\left(V_{in} + \varepsilon_{in} \geq V_{jn} + \varepsilon_{jn},\ \forall\ j \in C_n,\ j \neq i\right) \\ &= Pr\left(\varepsilon_{jn} - \varepsilon_{in} \leq V_{in} - V_{jn},\ \forall\ j \in C_n,\ j \neq i\right) \end{aligned} \tag{10}$$

In order to develop a random utility model for use with choice based data, a distribution of the error term must be specified. The assumptions about the error terms yield different probabilistic choice models.

Choosing the Type I Extreme Value (Gumbel) distribution for the error terms implies that their difference is logistically distributed. This statistical property produces a computationally convenient representation (multinomial logit model) of the probability of choosing a site as

$$P_n(i) = \frac{e^{V_{in}}}{\sum_{j \in C_n} e^{V_{jn}}} \qquad (11)$$

In addition to choosing a distribution for the error terms, they are also assumed to be independent and identically distributed.

An issue arising from the choice of error terms described above is the independence from irrelevant alternatives (IIA) property. This property can be explained with a simple example taken from Train (1986 p.19).

Suppose that an individual has a choice between two modes of transportation, car or bus, which yield the same utility. The probability of choosing either is 1/2 so the ratio of probabilities equal 1. Now a different coloured bus is included as a choice for transportation. One would expect that the probability of taking a car would remain the same but that the probability of choosing either bus would be 1/4. This is not the case in the multinomial choice models. What results is each choice receiving 1/3 probability of being chosen. The problem is that the probability of choosing the car option is underestimated and the probability of choosing the bus option is overestimated. Therefore if there are very close substitutes in a study another model, such as a nested logit model, may be appropriate.

Difficulties exist with the random utility analysis when dealing with certain socio-economic variables, such as education, income, or age. They are constant for each individual and do not differ over choice alternatives. If expressed as linear components in the utility function the socio-economic variables cancel out when the utility difference is calculated. For example, if utility is expressed as:

$$V_i = \beta(TC_i) + \alpha(educ) \tag{12}$$

the utility difference between site i and site j yields

$$\begin{aligned} V_i - V_j &= \left[\beta(TC_i) + \alpha(educ) - \beta(TC_j) - \alpha(educ)\right] \\ &= \beta(TC_i) - \beta(TC_j) \end{aligned} \tag{13}$$

Thus, the question is whether these variables provide significant information or explanatory power. If so, they can be incorporated into the model as an interaction variable, such as (distance ÷ income) or (distance x years of moose hunting experience).

Fletcher *et al.* (1990) note two benefits to using the RUM framework. First, the utility function defined for the RUM is able to include travel costs and site attributes, therefore the recreationist visits the site where the characteristics are most pleasing or preferred. This is a useful approach for examining policy initiatives which may involve changing site attributes. Second, the RUM specification provides a simple, easily calculable compensating variation equation in which to examine these attribute changes. Smith and Desvousges (1986) state that this type of analysis concentrates on individual decision-making and that researchers are able to observe recreationist's choices without complete information.

Problems with the RUM include the above mentioned IIA property, that all trips are assumed to be of the same length and independent of one another, and that the socioeconomic characteristics of individuals are not easily entered into such a model. With this general RUM overview, one can now examine the next step of model estimation.

Estimation

The method of Maximum Likelihood is used in the estimation of MNL model parameters. The likelihood function L, is defined as

$$\mathrm{L} = \prod_{n=1}^{N} \prod_{i \in C_n} P_n(i)^{y_{in}} \tag{14}$$

where: $P_n(i)$ is defined in the previous section and
y_{in} = {1 if person n chooses alternative *i*, and 0 otherwise}.

Thus, "this expression is simply the probability of each person's chosen alternative multiplied across all people in the sample" (Train, 1986 p.45).

Equation 14 is transformed further by taking the log of the likelihood function *L*, which yields

$$\begin{aligned} \mathcal{L} &= \sum_{n=1}^{N} \sum_{i \in C_n} y_{in}\left(P_n(i)\right) \\ &= \sum_{n=1}^{N} \sum_{i \in C_n} y_{in} \left(\beta' x_{in} - \ln \sum_{j \in C_n} e^{\beta' x_{jn}} \right) \end{aligned} \tag{15}$$

This can be stated simply as "the log of the probability of the chosen alternative of each person, summed over all sampled decision makers...(where) the estimate of ß is that which maximizes this sum" (Train 1986, p.45). The objective is to maximize the log likelihood function.

The reasons for using maximum likelihood estimation (MLE) are the ease of calculation using modern computer technology and the fact that the resulting estimators have desirable statistical properties (which characterize the sampling distribution of the estimator). A maximum likelihood estimate of ß "is simply the value of ß that maximizes the probability of drawing the sample actually obtained" (Kennedy, 1985 p.29). The three statistical properties associated with maximum likelihood estimators are: asymptotic unbiasedness, the mathematical expectation of an estimator $ß^*$ approaches ß (the true value) as the sample size increases; consistency, $ß^*$ approaches ß; asymptotic efficiency, $ß^*$ has minimum variance of all estimators as the sample size increases; and $ß^*$ assumes a normal distribution as the sample size increases, (Judge 1982, pp. 83-88). With the theoretical framework in place, it is now possible to examine how changes in attributes are valued.

THE THEORY OF WELFARE MEASUREMENT

There are three common ways in which to measure the value of a quantity, quality or price change, consumer surplus (CS), compensating variation (CV), and equivalent variation (EV). The appropriate measure to choose depends on the characteristics of the problem being evaluated. CS can be derived from an ordinary demand function whereas EV and CV are derived from income compensated demand functions.

The objective is to derive a money measure which correctly ranks an individual's preferences based on the utility function. This discussion will be based on two possible welfare measures for use in examining benefits and costs.

The question is how to incorporate estimated results with welfare theory to come up with a way of measuring the value of an environmental quality change. Continuing from the end of the economic theory section, and closely following Gravelle and Rees (1992) two measures of welfare are defined, Compensating Variation (CV) and Equivalent Variation (EV). Hicksian (compensated) welfare measures result from inverting the indirect utility function in describing the expenditure function approach.

One way of expressing CV is to examine the difference in utility associated with some environmental quality change. The indirect utility is defined as V(P, Q, M), where V is the indirect utility function, based on prices P, quality Q, and money income M. Compensating variation, based on an increase in a quality attribute, is the amount of money either positive or negative needed for the consumer to get back to his/her base utility level

$$V\left(P, Q^0, M\right) = V\left(P, Q^1, M + CV\right) \tag{16}$$

Based on the economic theory of inverting the indirect utility function, the expenditure function framework describes CV as

$$\begin{aligned} CV &= e\left(p^0,u^0\right) - e\left(p^1,u^0\right) \\ &= \int_{p_1^1}^{p_1^0} H_1\left(p,u^0\right)\,dp_1 \end{aligned} \tag{17}$$

where: $e\,(p,u)$ represents the expenditure function

$p^0, u^0, p^1,$ represent initial price, base utility and new price respectively

$H_1\ (p,\,u^0)$ represents the Hicksian demand for good x_1 .

Similarly, the Equivalent Variation can also be defined in the above two ways. EV is the amount of money that must be added to or subtracted from an individual at the initial scenario to make him/her as happy (as well off) at the new utility level

$$V\left(P,\,Q^1,\,M\right) = V\left(P,\,Q^0,\,M - EV\right) \tag{18}$$

Using the same notation as above, the EV derived from the expenditure function approach can be defined as

$$\begin{aligned} EV &= e\left(p^0,u^1\right) - e\left(p^1,u^1\right) \\ &= \int_{p_1^1}^{p_1^0} H_1\left(p,u^1\right)\,dp_1 \end{aligned} \tag{19}$$

where: $e\,(p,u)$ represents the expenditure function

$p^0, u^0, p^1,$ represent initial price, base utility and new price respectively

$H_1\ (p,\,u^0)$ represents the Hicksian demand for good x_1

These two measures of welfare do not produce the same value ordinarily. The only instance in which the CV and EV values are equal is when no income effect exists. This means that the income elasticity of the good (site) in question is zero. Moreover, these two welfare measures are considered unique as they are not path dependent. Thus, the order in which a price, quality or income change is evaluated over the above integral does not affect the welfare value.

With these assumptions it is now possible to select a welfare measure to use in conjunction with the estimated model. Research indicates that Compensating Variation is the preferred welfare measurement when estimating nonmarket benefits (Freeman, 1979; Braden and Kolstad, 1991), and for the multinomial logit model is derived as follows[5]

$$CV = -\frac{1}{\mu}\left[\left(\ln\sum_{i=1}^{N} e^{V_{i0}}\right) - \left(\ln\sum_{i=1}^{N} e^{V_{i1}}\right)\right] \tag{20}$$

where μ is the marginal utility of income
V_{i0} is the indirect utility for site i before a price (or quality) change
V_{i1} is the indirect utility for site i after a price (quality) change.

Assuming a constant marginal utility of income allows for the simple calculation of the CV measure. Without this assumption welfare estimates become complicated to calculate. In fact, μ is actually a modification of the estimated travel cost coefficient, β_{dist}.

---

[5] this is based on Small and Rosen (1981) *Econometrica* 49:105-130.

The estimated indirect utility function is expressed as

$$V_i = \beta(Y - TC_i) + \alpha(Q) \tag{21}$$

where V_i is the indirect utility associated with site i
Y is the individual's income
TC_i is the travel cost incurred to get to site i
Q is a vector of quality attributes

The marginal utility of income is obtained by taking the partial derivative of the indirect utility function with respect to income

$$\frac{\partial V_i}{\partial Y} = \mu = \beta \tag{22}$$

And, as described above, ß is the travel cost coefficient. In order to account for the return trip distance and cost of operating a vehicle (.27 / km, as stated by Alberta Motor Association 1993), the marginal utility of income used in calculating the welfare measures is derived as $\mu = ß_{dist} \div (2 \times .27)$.

To this point, the chapter has outlined the theoretical assumptions used in this analysis. But, there is one linkage which has not been addressed, the way in which environmental attributes can be measured.

MEASURING ENVIRONMENTAL ATTRIBUTES

Information, Attitudes and Behaviour

Recent literature suggests that studies about recreational site choice can be enhanced by examining the choice process. Understanding information acquisition, attitudes, mental maps, and behaviour of individuals assists the researcher in modeling the choices of recreational users. Information about sites is communicated to the recreationist through media, books, and word of mouth. With information, recreationists form attitudes about sites, perceptions about attributes and form a mental map of recreational site utility (Mercer 1971). Thus, knowledge about recreation sites enables the individual to make an informed decision about which site to visit and clarifies the mental map.

The idea of a mental map of recreational sites implies that individuals spatially organize the sites in their choice set. Therefore attitudes and perceptions about sites will influence the clarity with which sites are recognized and whether or not they are clearly represented in the mental map (Gould & White 1986). An individual will choose a site from his/her predetermined organization of sites thus spatial choice is another element to be considered in modeling behaviour and recreational site choice.

Abstracting from the marketing literature of Mehrotra & Palmer (1985), a recreational user perceives site quality at three stages in the visiting process: 1) During the preliminary phase, when the individual is thinking about taking a visit, gathering information, and giving consideration to specific activities and sites, 2) at the point before embarking on the journey, and 3) while visiting a site. One option is to consider a possible process of site quality perception to investigate the decision process and formulation of perceptions.

Site cues or tangible attributes of the site, are signals to the user about the benefit or utility of that site. Thus, quality cues and other site attributes stimulate perceptions about the site considered (Mehrotra & Palmer 1985). This literature also suggests an examination of the consumer's cognitive structure with respect to the organization of information and may well be consistent with recreational site choice modeling in the random utility framework.

Objective Attribute Data (expert opinion)

When quality is incorporated into nonmarket analyses, it is seen as a very scientific or physical measurement. This is done to include some "objective" or expert measure of the quality level of the attribute. These expert measures are based on scientific data or are provided by specialized individuals. Water quality is frequently measured in these types of analyses, and is included as a single-item scale measure or a numerical value. An example of this can be found in Cameron (1988) where water quality is indicated by varying concentrations of undesirable pollutants. Other examples such as including dissolved oxygen levels, contaminant levels, or increasing water quality from boatable to fishable or swimmable are ways in which to incorporate water quality into nonmarket studies (Smith & Desvousges 1986). Also, Peters (1993) included various measures of recreational fishing sites such as: fish catch rate, fish size, and type of water body. Some other attributes that have been examined are: game populations, number of individuals at a campsite, number of campsites, and road quality.

The incorporation of attribute quality is an advanced step in nonmarket analyses however, some individuals (Adamowicz 1991, Smith 1993, Cutter 1985, Freeman 1979, Craik & Zube 1976) have questioned the ability of these measures to reflect an individual's view of the quality and that perhaps perceptual measures of environmental quality should be examined in lieu or combined with the objective measures.

Perceived Attribute Data (subjective opinion)

Heberlein (1988) and Smith (1989) express the interdisciplinary nature of travel cost models in predicting recreation site choice behaviour. How individuals perceive site attributes may be entirely different from the objective measures at the sites. Stynes et al. (1985) state that "perceptual measures of site attributes should better capture cognitive aspects of park choices than physical measures" (p.27) . In other words, examining site choice decisions based on perceptions would better simulate an individual's decision.

Further, Gilbert White (1966) states that "there can be no thoroughly objective perception of the environment, only degrees of distortion which are minimized in rigorous scientific description" (White p.111). This implies that the "objective" opinion is defined within specific scientific parameters and those parameters may be based on other expert opinions. Thus objective data fall into a pre-determined scientific-subjective category. The objective data are really educated (highly trained) but subjective perceptions.

Each individual has images about places, and it is the individual's personality, learning, knowledge, experience, as well as external stimuli such as media, culture, and immediate environment which can all influence one's subjective (perceptual) evaluation of a place (Cutter 1985, p.17). In analyzing recreation site quality, one's perception of the site or attributes may be influenced by the whole experience or level of satisfaction with the trip (Craik & Zube 1976, p.23). This represents one difficult area of measuring an individual's perception in that each person has a subjective opinion and this may vary depending on one's surroundings or other dynamic circumstances.

One way to address this may be to ask individuals about their perceptions first and then ask what they think a more common group of people (ie. people in your neighborhood) would choose as the perception of that attribute (Brush 1976, p.50). Also, one can directly examine perceived and expert opinions to see how they differ (Appendix 4).

Another method used in the literature to model perceptions is a Likert scale (Shelby et al. 1989, Cameron 1988, Perdue 1987). These authors use seven point, ten point and five point scales in their surveys respectively which indicates the relative importance of an attribute level. The respondent chooses the level that they perceive is representative at the site. Another way to model perceptions is to ask people directly their opinion of a site attribute. For example, asking individuals about the distance in kilometers to the site they visited, or to choose (amongst a set of measures) the attribute level they feel best describes the site.

Incorporating users perceptions of site quality is a unique addition to the TCM framework. The derived Compensating Variation ("CV" - welfare measures) results will reflect an individual's perception of site attributes rather than objective measures. This is a useful addition to the CV analysis as individual's use perceptions of site attributes as their criteria for site choice decisions which may or may not be related to the actual attribute measures/levels.

The probability that a site is chosen can be estimated based on the attributes of the site. If the perceived attributes are used in place of the objective measures, one can predict the probability that the individual will choose a site based on his/her perception of the sites. Therefore, if policy proposals are put forth to close a particular site or change some of the attributes in some way, resource managers may have a better idea of the true impacts to the users themselves.

> "From an economic perspective, if damages to natural resources are to be based on human values they must be defined in a manner consistent with human perceptions. Natural and economic scientists must balance their analyses and find mechanisms for linking people's perceptions of a resource's services to scientific evaluations of the physical activities affected by any injury to the resource" (Kopp & Smith 1993, p.127).

Clearly, a common framework must be developed to link perceived and expert attribute measures. Expert attribute measures have been used in econometric models in the past, but this study also examines perceived measures in the random utility analysis.

SUMMARY

This chapter has discussed the necessary economic and econometric assumptions underlying the random utility approach to recreation valuation. In particular, a description of the random utility model and insight into site choice behaviour have been addressed. Including perceptions in site valuation studies is a step towards altering economic models to account for people's behaviour. Individual's make decisions based on information, experience, attitudes and from the resulting perceptions. Why then have researcher's not included perceptions of attribute levels in previous research? This exclusion may be due to the data collection problem, or a lack of understanding how to include these measures. Random Utility models provide one way in which to model site choice behaviour and to examine the perceptions of environmental attributes. The following chapter will discuss the data used in the analysis and the model descriptions.

CHAPTER 4 - THE DATA SET AND MODEL DESCRIPTION

INTRODUCTION

In 1992, the department of Rural Economy at the University of Alberta and the Canadian Forest Service collaborated in the preparation and administration of **The Alberta Moose Hunting Study**. The study was designed to obtain the following information about the moose hunters: socio-economic data; detailed records of moose hunting trips taken during the 1992 season; hunters' perceptions of site quality; how hunters may trade off different site attributes; and preferences and attitudes about moose hunting in west-central Alberta. A detailed summary of the questionnaire and preliminary results from the survey are found in McLeod *et al* (1993).

Resident general moose hunting license holders were surveyed from the following five towns: Whitecourt, Edson, Hinton, Drayton Valley, and Edmonton. "In-person" focus group meetings were chosen as the format for administering the questionnaire. The researchers believe that this allows for a more contemporary public participation approach (Hanemann, 1994). Also, this approach reduces possible bias in the responses as knowledgable individuals are present to answer any questions that the hunters may have. The research contained in this volume is based on a portion of the data collected from this survey.

The area of west central Alberta was chosen for this study because of the diverse characteristics of the hunters. Also, the area contains a good selection of hunting sites, and forestry activity is either present or possible in the future. Fifteen hunting sites or wildlife management units (WMUs) were chosen however, one site, WMU 439, was not visited by any of the hunters sampled during the 1992 season and thus was left out of the ensuing analysis.[6] A total of 223 usable questionnaires resulted. However, 33 questionnaires (individuals or "id's") were held back from the analysis so that specific model perfomance testing could be undertaken. Thus the following model discussion is based on a sample size of 190 individuals unless otherwise stated.

The questionnaire consisted of five major sections: 1) demographics and typical hunting trip characteristics, 2) a trip log (for hunters to fill in) outlining all of the moose hunting trips taken during the 1992 season, 3) an opinion table where hunters choose a level of quality corresponding to their perception of each of the five quality attributes at that site; 4) a contingent valuation question asking whether an individual would be willing to travel a further distance if the moose populations at a particular site, WMU 344, were improved, and lastly, 5) a site choice experiment where hunters made tradeoffs between the levels and availability of different site characteristics. The last two sections of the survey will not be analyzed in this thesis.

The names and addresses of the hunters were obtained from the Alberta Fish and Wildlife Division office in Edmonton. The interest in this study was overwhelming, thus it was not difficult to confirm a minimum number of participants. The response rates by town are reported in Appendix 2.

---

[6] A Map of the WMUs used in this study is found at the end of the survey sections in Appendix 1, and are based on the 1992 hunting guidelines for Alberta.

QUALITY DATA

One particular issue that the survey strives to address is the incorporation of quality attributes into a Random Utility Model. Specifically, should expert (objective or technical) measures of quality or perceived measures of quality (reported by the respondents) be included when analyzing site choice behaviour?

The five specific site quality attributes examined in this study are: distance to the WMU, road quality from home to the WMU, access within the WMU, congestion or number of other hunters encountered while hunting, and moose populations within the WMU. Another attribute, the presence or absence of recent forestry activity was excluded from this analysis. Although included in the questionnaire, this attriubte does not capture the intended effect as almost all of the WMUs appear to have some recent forestry activity.

These particular attributes of moose hunting sites were chosen as they are directly related to changes in forestry activity and may affect the enjoyment of the recreational experience. Also, these characteristics were deemed important after the researchers held a focus group meeting with some local Edmonton moose hunters and after having spoken with wildlife officers and biologists within the study area.

Table 4-1 explains the variable definitions stated in the survey and the initial coding of the variables before the effects code transformations. This table provides a review of the site quality (attribute) definitions. The respondents were asked to rate each of the WMUs using these definitions.

Table 4-1

Variable Definitions as Explained in the Survey and Initial Rating Values

Distance	The one way distance in kilometres from the hunter's home town to the centre of the WMU.
Road quality	The quality of the road from the hunter's home to the hunting area: 1= mostly paved, some gravel or dirt, 2= mostly gravel or dirt, some paved.
Access	Access within these hunting areas: 1= no trails, cutlines or seismic lines, 2= old trails, cutlines or seismic lines not passable without ATV, 3= Newer trails, cutlines or siesmic lines, passable with a 4WD, 4= Newer trails, cutlines or seismic lines, passable with 2WD. Only three levels were reported by experts, 2,3,4, but all four levels were reported by the hunters.
Congestion	Encountering other hunters during the course of a hunting day in the hunting area: 1= no hunters other than my hunting party are encountered, 2= other hunters hunting on foot are encountered, 3= other hunters on ATV's are encountered, 4 = other hunters in trucks are encountered. Only three levels were reported by the experts whereas all four levels were reported by the respondents.
Moose	Measure of moose populations in these hunting areas based on seeing or hearing moose or seeing fresh signs such as tracks, browse or droppings: 1= evidence of less than 1 moose per day, 2= evidence of 1 or 2 moose per day, 3= evidence of 3 moose per day, 4= evidence of more than 4 moose per day. All levels were reported by both groups.

Respondent's answers to the opinion table provide the perceived quality data. The opinion table (Appendix 1) requires each respondent to rate each of the five quality attributes for each of the fourteen WMUs. In cases where a respondent answered "I don't know" to a perceived quality level, the modal response particular to the respondent's home town replaced that value. The mode represents the most common response to a question.

Replacing the "I don't know" values with some other representative value is less than ideal however, this type of random utility model is incapable of dealing with the "I don't know" responses. Some may argue that this will bias the results by including non-existent data however, some effort needs to be made to account for the lack of usable responses. Another alternative is to exclude the individual's responses from the analysis, but useful information may be left out as a result. Thus, the choice was made to use the modal value as a proxy for the "I don't know" response.

The objective distance data were calculated using a rotary planimeter. This device is adjustable to the map scale being used, in this case 1 : 250,000 and measures distance by running the device along the roadways on a map. The one way distance from each of the five towns in the study area to the centre of each WMU was measured.

Data for the other four objective quality attributes were also obtained using the opinion table portion of the questionnaire. Fish and Wildlife officers and biologists were asked to fill out the opinion table based on their expert knowledge of the area. The most consistent responses were chosen as the expert (objective) quality measures (Appendix 3).

Both the objective and perceived quality data gathered from the opinion table, excepting objective distance, are categorical and organized in levels. The levels attempt to display an increasing degree of the attribute. A comparison of the perceived and objective ratings is presented in Appendix 4. Reviewing these tables shows a distinct variation between some of the attributes at certain sites.

Qualitative categorical data such as the perceived and objective quality data, can cause statistical interpretation problems thus it is necessary to transform the data so that they are usable within an economic and statistical framework. One way to accomplish this is to create effects codes (Louviere, 1988). These effects codes produce estimates which allow for variation between attribute levels rather than a (0,1) coding scheme, which defines a contrast with an option being the origin (Louviere, 1988).

The effects code transformations depend on the way in which the variable is to be expressed in the model as well as on the number of levels reported by the experts (for objective data) and by hunters (for perception data). Access, congestion, and moose population attributes have the potential of reporting four levels (excluding the "I don't know option") whereas road quality has up to two levels (these correspond to the choices in the opinion table of the survey.

If a quality variable shows m levels of variation, then the resulting number of variables after the transformation equals m-1. There are four levels describing moose populations (plus the "I don't know" option). Therefore the attribute is transformed into: 4 - 1 = 3 variables corresponding to MP1, MP2, MP3, which correspond to level 1, level 2, and level 3 (where MP4, level

4, represents the base case). The base case is represented by the negative sum of the other levels 1, 2, 3. The negative (sum) is required because the variable associated with the base case is given an effects code of -1.

An example of the moose population variable effects code transformation is found in Table 4-2. The transformed variables used in the models for this research are displayed in Table 4-3 and Table 4-4. As seen from this table, some of the objective quality variables do not have the same number of variables (attribute levels) as the perceived variables. In addition, the unique feature of effects code transformation is that this allows the coefficients to be interpreted as marginal utilities associated with the particular level.

Table 4-2 : Effects Coding for Moose Population Variable

level	variable		
	MP1	MP2	MP3
1	1	0	0
2	0	1	0
3	0	0	1
4	-1	-1	-1

where: MP1, MP2, MP3 are the moose population levels associated with the opinion table

Table 4-3

Transformed Variables Included in The Objective Measures Model

OBDIST	The one way distance in kilometres from the hunter's home town to the centre of the WMU.
OBRDQ	This road quality variable takes on the value -1 if level 1 is chosen and 1 if level 2 is chosen.
ACC1	If (access=4) ACC1=-1, (access=3) ACC1=0, (access=2) ACC1=1.
ACC2	If (access=4) ACC2=-1, (access=3) ACC2=1, (access=2) ACC2=0.
OBCGST	If (congestion=4) OBCGST=-1, (congestion=3) OBCGST=1.
MP1	If (moose=4) MP1=-1, (moose=3) MP1=0, (moose=2) MP1=0, (moose=1) MP1=1.
MP2	If (moose=4) MP2=-1, (moose=3) MP2=0, (moose=2) MP2=1, (moose=1) MP2=0.
MP3	If (moose=4) MP3=-1, (moose=3) MP3=1, (moose=2) MP3=0, (moose=1) MP3=0.

Table 4-4

Transformed Variables Included in The Perceived Measures Model

OBDIST	The one way distance in kilometres from the hunter's home town to the centre of the WMU.
PRDQ	This road quality variable takes on the value -1 if level 1 is chosen and 1 if level 2 is chosen.
PAC1	If (access=4) PAC1=-1, (access=3) PAC1=0, (access=2) PAC1=0, (access=1) PAC1=1.
PAC2	If (access=4) PAC2=-1, (access=3) PAC2=0, (access=2) PAC2=1, (access=1) PAC2=0.
PAC3	If (access=4) PAC3=-1, (access=3) PAC3=1, (access=2) PAC3=0, (access=1) PAC3=0.
PCON1	If (congestion=4) PCON1=-1, (congestion=3) PCON1=0, (congestion=2) PCON1=1.
PCON2	If (congestion=4) PCON2=-1, (congestion=3) PCON2=1, (congestion=2) PCON2=0.
PMP1	If (moose=4) PMP1=-1, (moose=3) PMP1=0, (moose=2) PMP1=0, (moose=1) PMP1=1.
PMP2	If (moose=4) PMP2=-1, (moose=3) PMP2=0, (moose=2) PMP2=1, (moose=1) PMP2=0.
PMP3	If (moose=4) PMP3=-1, (moose=3) PMP3=1, (moose=2) PMP3=0, (moose=1) PMP3=0.

DETERMINING THE CHOICE SET

Another area of interest concerning behavioural linkages is the examination of ways in which to determine the size of an individual's choice set. For example, if a respondent is not aware of a certain site, what is the probability that he/she will choose it? Parsons and Kealy (1993) and Peters (1993) argue that sites an individual is unaware of should not be included in the choice set.

In the marketing literature, the choice set is referred to as the "consideration set". "Therefore, accurate identification of the consideration set is essential to the practical success of [choice] modeling applications" (Brown and Wildt 1992, p.235). Simply asking hunters which sites are they aware of does not necessarily address the choice set question. In fact, Brown and Wildt (1992) state that research suggests that choice set or consideration set size is approximately one half the size of the awareness set.

This study examined one way in which to incorporate the notion of a reduced choice sets into the analysis and is described as follows. The original data set was modified such that any hunter who chose "I don't know" for all five of the quality attributes at a particular site (the opinion table of the questionnaire see Appendix 1), had that site removed from his/her choice set. The reason for this specification is that individuals make site choices based on past experience/use, attitudes, perceptions of attributes, information and expected satisfaction. Perdue (1987) states that "utility is considered to be a function of the individual's perception of the attributes of the known [site] and preference for those attributes" (Perdue 1987, p.17). Therefore, determining each hunter's choice set based on their perceptions of the site attributes was one way in which to address the choice set issue.

MODEL DESCRIPTION

The variables chosen for the four models are based on: preliminary focus group discussions with moose hunters outlining relevant site attributes, recent developments in the literature, and researcher beliefs. The choice of a linear indirect utility function, random utility framework, multinomial logit specification, and "effects" code variable transformation is also based on recent literature and researcher opinions. The general model, equation (8), described in Chapter 3 is the form that the four models take in estimation. Five quality attributes are included in the analysis: distance, road quality, access, congestion, and moose populations.

The two sets of variable definitions, for the objective measure data and for the perceived measure data, are further subdivided into full choice set and reduced choice set models. The full choice set specification refers to the inclusion of all 14 WMUs available to the hunter for each choice occasion. The study area includes 14 WMUs and thus, all will be included in the full choice set model.

Conversely, the reduced choice set model refers to a change in the number of sites available from which the hunter can choose. Some may have all 14 sites in their "choice set" whereas others may only have one or two sites included in their choice set. Therefore, the choice sets vary for each hunter in this analysis. The determination of the number of alternatives within each choice set is based on the sites which the hunter has indicated an opinion or perception. If the hunter has reported (selected) an attribute level for each of the five attributes used in the analysis (in the survey) then this site will be included in his/her choice set.

Parsons and Kealy (1992) state that there is "the possibility of bias due to erroneously including alternatives that individuals may not consider in their site choice" and that including all of the sites in the study may over state the number of substitute sites available to the hunter (Parsons and Kealy 1992, p.96). They further suggest that perhaps choosing sites based on someone's perception or awareness of a site may be more correct and that comparing models with a full set of alternatives and a reduced choice set is appropriate (Parsons and Kealy 1992, p.97). Incorporating these techniques results in four models for estimation based on the variable descriptions in the above two tables for both the full choice set and reduced choice set scenarios.

SUMMARY

The information collected from the Alberta Moose Hunting Study questionnaire provides the necessary data for a variety of simple or more complex analyses. The project report (McLeod *et al.* 1993) provides simple summary statistics, hunter characteristics and general background information. This thesis will examine one econometric application, a discrete choice random utitility model of moose hunting site choice based on the incorporation of perceived site attribute measures. A discussion of the results of the econometric techniques discussed in this and previous chapters will be presented in the following chapter.

CHAPTER 5 - ESTIMATION RESULTS AND POLICY SIMULATIONS

INTRODUCTION

Having defined the theoretical framework in Chapter 3 and explained the data used in the analysis and resulting model description in Chapter 4, this section will focus on estimation results and policy simulations. The results from the model estimation provide information to calculate the probability that a hunter will choose a particular site. With these estimated functions, simulations representing possible policy objectives are produced. The probability that moose hunters will choose particular sites when site attributes are altered is examined and the welfare estimates derived from these changes are discussed.

ESTIMATION RESULTS

Four separate random utility models corresponding to the full choice set objective measures (FCO), full choice set perceived measures (FCP), reduced choice set objective measures (RCO), and reduced choice set perceived (RCP) measures were estimated and the resulting parameter estimates are found in Table 5-1, Table 5-2, Table 5-3, and Table 5-4 respectively. The variables correspond to the earlier descriptions in Chapter 4. These models were generated using LIMDEP version 6.0 (Greene, 1992), which employs the method of Maximum Likelihood for estimation. The results are examined within this structure as well as a comparison between the perceived and objective attribute framework.

Table 5-1

Model 1 - Full Choice Set Objective Measures[7]

```
Discrete Choice Model
Observations =    190


Discrete Choice Model
Maximum Likelihood Estimates
Log-Likelihood.............     -2075.085
Restricted (Slopes=0) Log-L.    -2615.306
Chi-Squared ( 8)...........      1080.442
Significance Level.........      0.0000000
Rho-Squared................      0.2065

Variable  Coefficient  Std. Error   t-ratio Prob|t|≥x
-----------------------------------------------------
OBDIST   -0.99966E-02   0.7078E-03  -14.123  0.00000
OBRDQ     0.26279       0.6454E-01    4.072  0.00005
ACC1      0.56789       0.5220E-01   10.879  0.00000
ACC2     -0.20630       0.6571E-01   -3.140  0.00169
OBCGST   -0.77087       0.7586E-01  -10.162  0.00000
MP1      -0.60746       0.8925E-01   -6.807  0.00000
MP2      -0.54407       0.6081E-01   -8.947  0.00000
MP3      -0.18377       0.7978E-01   -2.303  0.02126
```

---

[7] Where: OBDIST = distance, OBRDQ = road quality, ACC1 & ACC2 = levels of access, OBCGST = congestion, MP1, MP2, MP3 = levels of moose populations. Refer to Chapter 4 p. 43-46 for a more detailed explanation.

Table 5-2

Model 2 - Full Choice Set Perceived Measures[8]

```
Discrete Choice Model
Observations =    190


Discrete Choice Model
Maximum Likelihood Estimates
Log-Likelihood.............    -1780.143
Restricted (Slopes=0) Log-L.   -2615.306
Chi-Squared (11)...........     1670.325
Significance Level.........     0.0000000
Rho-Squared................     0.3193

Variable  Coefficient  Std. Error   t-ratio Prob|t|≥x
------------------------------------------------------
OBDIST   -0.10131E-01  0.5774E-03  -17.546  0.00000
PRDQ      0.39355      0.4739E-01    8.305  0.00000
PAC1     -2.4030       0.5406       -4.445  0.00001
PAC2      0.50648      0.1919        2.640  0.00830
PAC3      0.92243      0.1905        4.843  0.00000
PCON1     0.46614      0.1462        3.188  0.00143
PCON2     0.45500      0.1078        4.222  0.00002
PCON3    -0.84443E-01  0.8396E-01   -1.006  0.31455
PMP1     -1.7576       0.8283E-01  -21.220  0.00000
PMP2     -0.35248      0.6874E-01   -5.128  0.00000
PMP3      0.37948      0.8497E-01    4.466  0.00001
```

---

[8] Where: OBDIST = distance, PRDQ = road quality, PAC1, PAC2, PAC3 = levels of access, PCON1, PCON2, PCON3 = levels of congestion, PMP1, PMP2, PMP3 = levels of moose populations. Refer to Chapter 4 p. 43-46 for a more detailed explanation.

Table 5-3

Model 3 - Reduced Choice Set Objective Measures[9]

```
Discrete Choice Model
Maximum Likelihood Estimates
Log-Likelihood.............    -1702.071
Restricted (Slopes=0) Log-L.   -2059.342
Chi-Squared ( 8)...........     714.5435
Significance Level.........     0.0000000
Rho-Squared................    0.1734

Variable  Coefficient  Std. Error   t-ratio Prob|t|≥x
-----------------------------------------------------
OBDIST   -0.83584E-02   0.7882E-03  -10.604  0.00000
OBRDQ     0.25292       0.6528E-01    3.874  0.00011
ACC1      0.44798       0.5696E-01    7.865  0.00000
ACC2     -0.42178       0.7736E-01   -5.452  0.00000
OBCGST   -0.62487       0.8064E-01   -7.749  0.00000
MP1      -0.60785       0.9176E-01   -6.624  0.00000
MP2      -0.61206       0.6703E-01   -9.131  0.00000
MP3      -0.32793E-01   0.8598E-01   -0.381  0.70290
```

---

[9] Where: OBDIST = distance, OBRDQ = road quality, ACC1 & ACC2 = levels of access, OBCGST = congestion, MP1, MP2, MP3 = levels of moose populations. Refer to Chapter 4 p. 43-46 for a more detailed explanation.

Table 5-4

Model 4 - Reduced Choice Set Perceived Measures[10]

```
Discrete Choice Model
Maximum Likelihood Estimates
Log-Likelihood..............    -1515.013
Restricted (Slopes=0) Log-L.    -2059.342
Chi-Squared (11)............     1088.659
Significance Level..........     0.0000000
Rho-Squared.................   0.2643

Variable  Coefficient  Std. Error   t-ratio Prob|t|≥x
-----------------------------------------------------
OBDIST   -0.88040E-02   0.6309E-03  -13.955  0.00000
PRDQ      0.19743       0.5100E-01    3.871  0.00011
PAC1     -10.346        161.0        -0.064  0.94877
PAC2      3.3978        53.67         0.063  0.94952
PAC3      3.5695        53.67         0.067  0.94698
PCON1     0.32029       0.1478        2.167  0.03025
PCON2     0.38044       0.1134        3.353  0.00080
PCON3    -0.96365E-01   0.9123E-01   -1.056  0.29085
PMP1     -1.7020        0.8982E-01  -18.948  0.00000
PMP2     -0.30876       0.7832E-01   -3.942  0.00008
PMP3      0.21134       0.9118E-01    2.318  0.02045
```

---

[10] Where: OBDIST = distance, PRDQ = road quality, PAC1, PAC2, PAC3 = levels of access, PCON1, PCON2, PCON3 = levels of congestion, PMP1, PMP2, PMP3 = levels of moose populations. Refer to Chapter 4 p. 43-46 for a more detailed explanation.

FULL CHOICE SET MODELS

Each coefficient represents the marginal utility associated with that attribute level. The estimated coefficient on the travel cost proxy, OBDIST has the expected negative sign for both Model 1 and Model 2. This expectation is based on the notion that as the distance traveled to a site increases, the utility and probability of a moose hunter visiting that site will decrease. Intuitively, most individuals do not enjoy long drives to recreation areas, they are more interested in arriving at the site quickly to begin their activity. The coefficient values are very close, however, the standard error is smaller and the t-ratio is larger in the perceived attribute model (Model 2) implying a greater significance for this model .

The road quality variables (OBRDQ & PRDQ) are coded through the effects code transformation to reflect the base case of paved roads. The variables exhibit a positive sign (positive utility) for the second level, un-paved roads, in both models. This positive utility associated with un-paved roads suggests that better quality roads allow highway vehicles easy access to the areas, thus more hunters may be present potentially resulting in increased congestion and less moose. Further, the negative of each variable, which gives the utility associated with the base case outcome paved roads is negative.[11] The parameter estimates are relatively close, but again the standard error is smaller and the t-ratio larger in the perceived measure model.

Effects codes transform the access attribute into two and three variables for Model 1 and Model 2 respectively. The access attribute in Model 1 has two variables because only three of the four possible levels describing access were chosen by the experts (level 2, 3, 4, see Table 4-1) whereas each of the four levels were chosen by the hunters (perceived measures). The base case for access is level four, the greatest amount of access.

---

[11] Refer to Chapter 4 p. 43-46 for an explanation of effects codes transformation and interpretation.

In Model 1, ACC1 is positive, ACC1 corresponds to a very low level restricted amount of access. This implies that a restricted amount of access yields a positive utility. ACC2 is negative therefore ATV type access also yields a negative utility. To examine the utility associated with the base case, the third level of access described as general access (with a 2WD vehicle), the negative sum of the access coefficients is calculated: - (0.56 + - 0.206) = - 0.359, thus the most general level of access yields a negative utility.

Conversely in Model 2, PACC1 is negative therefore a restricted amount of access yields a negative utility to hunters (perceived measures). The second level, PACC2 shows an increase from PACC1 and is positive indicating a positive utility associated with ATV type (more) access. Further, PACC3 shows a greater coefficient value and positive utility associated with the common 4WD type of access. To examine the utility associated with the base case, the fourth level of access described as general (very easy) access (with 2WD vehicle), the negative sum of the access coefficients produces: - (- 2.4 + 0.5 + 0.9) = 1, a positive utility associated with this type of access.

The results from Model 1 and Model 2 are contradictory and interesting. The objective measure model indicates that access is not preferred. This reflects the intentions of the hunters as noted in the focus group discussions. However, the perceived model results indicate that increased access is preferable. One possible explanation is that the hunters like access for themselves but not for everyone else. Moreover, access and congestion are likely correlated and this may also account for these results.

A comparison of the coefficient values, standard errors, and t-ratios reveal that both models exhibit statistically significant properties for the access variable; however, in Model 1 the standard errors are smaller and the t-ratios larger indicating greater significance. Also, the coefficient estimates are not directly comparable as Model 1 has two variables and Model 2 has three variables for access.

The congestion attribute is represented by one variable in Model 1 OBCGST, and three variables in Model 2, PCON1, PCON2, PCON3. In Model 1, OBCGST = - 0.7708, this implies a negative utility associated with the third level of congestion (other hunters on ATV's are encountered). The negative of this value is 0.7708, and represents the utility associated with the base case level, implying a positive utility for this type of access (other hunters in trucks are encountered). This seems counter-intuitive as a greater degree of congestion is not generally preferred. Some other underlying reason may exist for this result such as probable correlation between the access and congestion variables as mentioned above.

In Model 2, the coefficients indicate that the two low levels of congestion have a somewhat positive utility, the third (high) level of congestion has a negative utility but specifically the coefficients and utility decrease over the range as congestion increases. Thus confirming that as congestion increases, the utility associated with that site decreases and the probability of choosing that site will decrease. This result is intuitive as most hunters typically do not wish to encounter other hunters unless they are from their own party. They consider this bothersome and also, encountering other hunters could imply a reduced bagging opportunity.

One of the most important variables if not the main area of concern is moose populations. The hunters surveyed were quite distressed about the moose population levels and therefore a positive sign for the base case (highest level of moose populations) is expected for this variable (ie. as moose populations increase so does the probability of visiting the site and the hunter's utility). Both Model 1 and Model 2 exhibit an increase in coefficient values as moose populations increase from the low population level to the high population level, indicating an increase in utility.

Examining the coefficients individually in Model 1 show a negative utility associated with each level. However, this is decreasing over the range and the negative sum of the coefficients (the utility associated with the base case level 4) is a large positive. A similar result is noted for Model 2. A larger negative coefficient for the lowest level of moose populations (which is intuitive), a smaller negative at the next level, a small positive for level three, and the negative sum of these is also a large positive indicating a positive utility or importance associated with the highest level of moose populations.

REDUCED CHOICE SET MODELS

The coefficients from the reduced choice set models (Model 3 uses objective measures and Model 4 uses perceived measures) are similar to those above. Briefly, OBDIST in both models is negative as expected, significant, and has a lower standard error and higher t-ratio in Model 4, the perceived measure model.

The same phenomenon particular to the access variables discussed in the full choice set models above occurs in these two models as well. Both Model 3 and Model 4 exhibit a positive utility for the base case, general type of access. However, examining the coefficient effects individually reveals that the restricted type of access, the 1st level, is positive in Model 3 then it becomes negative, and the base case, the negative sum, is positive. This may not concur with expectations as the hunters stated in the discussion session their desire for a reduction in access. However, many owned or used ATV's while hunting indicating a preference for access. In Model 3, the low level of access is positive and the next level of access is negative which is consistent with the information put forth by the hunters during the discussion session.

In Model 4 the same result occurs. The access variables exhibit the same signs as in Model 2. Reviewing the coefficients more closely, the second access level, PAC2 actually increases in value from PAC1, and PAC3 is also positive and increases which is counter-intuitive for the reasons stated above. This is interesting as it implies a positive utility associated with the second and third (more common) types of access.

One note regarding the estimates in Model 4 is the insignificance of the access coefficients, PAC1, PAC2, PAC3. The values of the coefficients are much larger than any of the other three estimated models, and none of the variables are significant. Access is deemed to be an important determinant of moose hunting site choice and thus is retained in the model. In doing so, the researchers attempt to capture the separate effects of access and congestion, but perhaps the effect of access is being captured in the congestion variable or elsewhere.

Another way to examine these model results is to compare the models based on the similarities in their variable definitions. The objective measure models (Model 1 and Model 3) vs. the perceived measure models (Model 2 and Model 4). Model 1 and Model 3 have all of the same signs on the coefficients. However, the FC model appears to perform better in terms of slightly smaller standard errors and larger t-ratios. Similarly, a comparison of Model 2 and Model 4 also reveals the above mentioned conclusions.

A simple summary statistic indicating the goodness of fit of a model is McFadden's pseudo rho-squared.[12] These statistics are reported with the model estimation results. The full choice set data, Model 2, which uses perceived measures of the quality attributes, has a higher pseudo rho-squared value of 0.319 than Model 1, rho-squared = 0.2065. In Addition, the McFadden's pseudo rho-squared value is higher in Model 4 using the perceived attribute measures compared to Model 3. The pseudo-rho squared values are lower compared to traditional R-squared values but are significant. This is because the upper bound is typically lower for the pseudo rho-squared values (Maddala, 1983). Therefore, with discrete choice models, traditional R-squared values and the associated upper bounds are inappropriate.

There are other methods of comparing the predictive ability of a model and the significance of model results. In the following section techniques such as nested tests, comparing the predicted probabilities, percent correct predictions and out of sample prediction success will be evaluated.

---

[12] This is calculated as 1 - (log likelihood unrestricted / log likelihood restricted) see Maddala p.40.

PREDICTIVE ABILITY

Wald Test

One test which is used to examine the model structure is the nested test or "Wald Test" as defined by Greene (1992) in the LIMDEP manual. In this hypothesis test, two models are estimated and compared. One model with all of the variables included, a base model, is compared with a model including only the variables that are deemed relevant, the restricted model. This is done to see if one model is statistically significant from the other, ie. whether adding or deleting variables improves the predictive ability of the model.

In this example three models were estimated for both the full choice set and reduced choice set data. First, a model is estimated which includes all of the variables, both perceived and objective measures. Then, a restricted model is estimated where all of the perceived variables are set equal to zero. The "Wald Test" calculates a chi-squared value to examine the effect of the restriction. Third, another restricted model is estimated where all of the objective variables are set equal to zero. This is also compared to the first (full) variable model and a "Wald Test" chi-squared value is generated to test this restriction. A total of four "Wald Test" chi-square values are calculated for the full choice set and reduced choice set data.

For the full choice set data, a restriction setting all of the objective attribute coefficients equal to zero yields a chi-squared value of 161.527, which is greater than the critical (decision) level (Judge, 1982). Also, a restriction setting all of the perceived measures equal to zero yields an even larger chi-squared value of 617.825, which is also greater than the critical decision value. Since the chi-squared values exceed the critical values, the null hypothesis is rejected that the coefficients equal zero. They are significantly different from zero and important indicators for the model estimation, thus should be included in the model.

The same magnitude of values described above are found for the reduced choice set data. Setting the objective attribute coefficients equal to zero yield a chi-squared value of 133.052, and setting the perceived attribute coefficients equal to zero yields a chi-squared value of 479.561. Both are larger than the critical decision value. Significantly larger chi-squared values are observed for the perceived measure models, an indication of the importance of these variables.

This is an interesting result as each Wald test indicates that the variables are significant, ie. objective measures add information to a model based on perceptions and vice versa. One may propose that the combined perceived and objective model should be used for the analysis. However, this is somewhat problematic in terms of the behavioural implications and econometric drawbacks. Particularly, it is difficult to conceive of a theoretical model that includes both the perceived and objective attributes in one model, and there may be significant correlation among perceived and objective attribute measures creating statistically weak estimates and problems with interpretation. This inconclusive result indicates that further analysis is required and is undertaken in the following section.

Prediction

Predicted probability tables are calculated from the model estimates. The four model prediction tables are shown in Table 5-5 and Table 5-6.

TABLE 5-5

Distribution of Predicted and Actual Number of Trips
Full choice set objective measures

Site	Number of trips Actual	Number of trips Predicted
337	85.00	75.90
338	88.00	99.00
340	94.00	67.90
342	62.00	43.50
344	46.00	73.90
346	258.00	246.90
348	124.00	123.90
350	142.00	134.40
352	26.00	16.40
354	24.00	7.80
356	16.00	4.60
437	6.00	22.20
438	1.00	10.30
507	19.00	63.40

Distribution of Predicted and Actual Number of Trips
Full choice set perceived measures

Site	Number of trips Actual	Number of trips Predicted
337	85.00	83.70
338	88.00	78.70
340	94.00	93.70
342	62.00	52.90
344	46.00	60.00
346	258.00	144.30
348	124.00	166.90
350	142.00	105.00
352	26.00	40.70
354	24.00	19.30
356	16.00	5.10
437	6.00	32.70
438	1.00	33.40
507	19.00	73.70

TABLE 5-6

Distribution of Predicted and Actual Number of Trips
Reduced choice set objective measures

	Number of trips	
Site	Actual	Predicted
337	77.00	69.30
338	87.00	98.60
340	90.00	75.80
342	62.00	50.20
344	44.00	61.70
346	254.00	242.30
348	121.00	120.90
350	129.00	129.50
352	25.00	19.00
354	21.00	9.40
356	16.00	5.30
437	6.00	16.80
438	1.00	7.60
507	19.00	44.80

Distribution of Predicted and Actual Number of Trips
Reduced choice set perceived measures

	Number of trips	
Site	Actual	Predicted
337	77.00	83.90
338	87.00	86.40
340	90.00	88.00
342	62.00	53.50
344	44.00	55.10
346	254.00	132.60
348	121.00	171.40
350	129.00	106.20
352	25.00	38.00
354	21.00	16.40
356	16.00	6.60
437	6.00	32.50
438	1.00	26.70
507	19.00	54.10

Based on the data, the probability that an individual chooses site *i* is calculated as the predicted trip.[13] A quick visual comparison of the actual distribution of trips to the predicted distribution of trips gives the researcher some insight into the predictive ability of the model. Table 5-5 displays the distribution of predicted vs. actual number of trips for Model 1 and Model 2. Both sets of predicted trip distributions greatly over predict the number of trips for the last 3 WMUs, 437, 438, 507. Table 5-6 displays the distribution of predicted vs. actual trips for Model 3 and Model 4. These also over predict the number of trips for the WMUs mentioned above. A large number of predicted trips occur at the most popular WMUs 346, 348, 350 for both models. However, this comparison of predicted trip distribution on its own is not that helpful in examining predictive ability.

Another method of judging model performance based on predicted probabilities is called a prediction success table (Maddala, 1983). This table shows the number of predicted trips that were actually taken to each site, Table 5-7, Table 5-8, Table 5-9, Table 5-10 which are displayed in Appendix 5. The sum of each row gives the total number of trips taken to the site, whereas the sum of each column gives the total number of predicted trips to each site. Also, the diagonal elements show the number of correct predictions, or, the number of predicted trips to site *i* that were actually taken to site *i*. From this, the percent correct predictions can be calculated. This statistic is simply the sum of the diagonal elements divided by the total number of trips taken. This value is reported at the bottom of each table (% CORR PRED) and is thought to be a good indicator of predictive ability (Maddala, 1983).

---

[13] Vi = indirect utility which is calculated by taking each coefficient multiplied by the data point for person i for each variable then summing it up. The probability of choosing a site is calculated from equation 11.

Further, an overall prediction success index (PSI) is calculated for each table based on the distribution of predicted and actual number of trips.[14] This index allows for a comparison across models as to the model's success in predicting trips or more commonly called a 'Goodness of Fit' test. A maximum value (or upper limit) of this PSI is also calculated for relative comparison. Model 4, the reduced choice set perceived measure model, is the strongest model based on the highest percent correct predictions and the greatest PSI.

Out of Sample Test

Horowitz and Louviere (1993) suggest an out of sample technique for testing a model's predictive ability. This measure can be achieved when a portion of the sample is kept aside from the main analysis. In this research, 223 id's were considered usable, and 33 randomly selected id's were removed from this 'main' data set. This group of 33 id's is called the 'out of sample' data set. As stated in Chapter 4, the previous discussion of model results is based on the main sample of 190 id's.

The purpose of this 'out of sample' (OS) test is to examine if the models generated from the main data set are able to perform significantly well in predicting choices for this smaller data set. A few notes regarding the preparation of the OS data are required.

The data are transformed into effects codes as described in Chapter 4. In addition, not all 14 sites were visited by the individuals in this OS data set.

---

[14] The prediction success index (PSI) is derived on p.76-77 in Maddala, 1983.

Because of this, the following WMUs were deleted: WMU 340, 356, 437. The total number of trips taken for the OS data equals 137 for the full choice set group and 136 for the reduced choice set group. The coefficients from Model 1, Model 2, Model 3, and Model 4 are used in conjunction with the OS data to obtain indirect utility functions from which predicted probabilities and prediction success tables are generated. The predicted probabilities are displayed in Table 5-11, Table 5-12 and the prediction success tables are displayed in Appendix 6 (Table 5-13, Table 5-14, Table 5-15, Table 5-16).

TABLE 5-11

"Out of Sample" Data

Distribution of Predicted and Actual Number of Trips
Full choice set objective measures

Number of trips = 137

Site	Actual	Predicted
337	1.00	9.10
338	1.00	13.40
342	10.00	6.10
344	5.00	12.70
346	35.00	33.40
348	32.00	20.10
350	36.00	25.40
352	8.00	2.60
354	2.00	1.60
438	1.00	1.80
507	6.00	10.30

Distribution of Predicted and Actual Number of Trips
Full choice set perceived measures

Number of trips = 137

Site	Actual	Predicted
337	1.00	6.60
338	1.00	5.30
342	10.00	8.70
344	5.00	8.10
346	35.00	14.00
348	32.00	32.50
350	36.00	18.40
352	8.00	9.40
354	2.00	5.90
438	1.00	7.50
507	6.00	20.10

TABLE 5-12

"Out of Sample" Data

Distribution of Predicted and Actual Number of Trips
Reduced choice set objective measures

Site	Number of trips = 136	
	Actual	Predicted
337	1.00	4.80
338	1.00	9.40
342	10.00	7.70
344	5.00	12.40
346	35.00	34.20
348	32.00	19.40
350	36.00	27.40
352	7.00	3.80
354	2.00	2.00
438	1.00	1.80
507	6.00	12.60

Distribution of Predicted and Actual Number of Trips
Reduced choice set perceived measures

Site	Number of trips = 136	
	Actual	Predicted
337	1.00	5.50
338	1.00	5.80
342	10.00	7.50
344	5.00	6.20
346	35.00	12.70
348	32.00	33.90
350	36.00	22.00
352	7.00	9.90
354	2.00	5.80
438	1.00	8.00
507	6.00	18.20

The four prediction success indices (PSI, located at the bottom of the Prediction Success Tables) are lower than those in the main data set models. The percent correct predictions are also lower except for Model 1, which is higher. The conclusion is that the estimated models predict similar results on the OS data. The OS results also show that Model 4, the varying choice set perceived measures model, is the most significant model with the highest PSI and percent correct predictions. Therefore the reduced choice set perceived measure model is rated the best in terms of model performance.

Another type of predicted probabilities test suggested by Horowitz and Louviere (1993) is based on using each individual's highest indirect utility associated with each trip as a proxy for the predicted choice. Then, a comparison of the predicted trips, based on assigning the highest utility, vs. the actual number of trips can also be examined. These results are displayed in Table 5-17 and Table 5-18.

The two models using the objective measures (FCO, RCO) predict trips at WMU 346, 348, 350 and WMU 344, 346, 348, and 350 respectively. The perceived measure models (FCP, RCP) predict trips over the entire (range) set of WMUs. The objective measure models predict trips around the most popular hunting sites. The perceived measure models also predict a large number of trips around the most popular sites but predict trips over the range of sites which is consistent with the actual distribution of trips. This indicates that the perceived models better approximate choice behaviour.

TABLE 5-17

"Out of Sample" Data

Hunter's highest utility as a proxy for predicted site choice

Distribution of Predicted and Actual Number of Trips
Full choice set objective measures

Number of trips = 137

Site	Actual	Predicted
337	1.00	0.00
338	1.00	0.00
342	10.00	0.00
344	5.00	0.00
346	35.00	72.00
348	32.00	1.00
350	36.00	64.00
352	8.00	0.00
354	2.00	0.00
438	1.00	0.00
507	6.00	0.00

Distribution of Predicted and Actual Number of Trips
Full choice set perceived measures

Number of trips = 137

Site	Actual	Predicted
337	1.00	3.00
338	1.00	1.00
342	10.00	7.00
344	5.00	0.00
346	35.00	11.00
348	32.00	46.00
350	36.00	39.00
352	8.00	10.00
354	2.00	0.00
438	1.00	8.00
507	6.00	12.00

TABLE 5-18

"Out of Sample" Data

Hunter's highest utility as a proxy for predicted site choice

Distribution of Predicted and Actual Number of Trips
Reduced choice set objective measures

Number of trips = 136

Site	Actual	Predicted
337	1.00	0.00
338	1.00	0.00
342	10.00	0.00
344	5.00	4.00
346	35.00	56.00
348	32.00	5.00
350	36.00	71.00
352	7.00	0.00
354	2.00	0.00
438	1.00	0.00
507	6.00	0.00

Distribution of Predicted and Actual Number of Trips
Reduced choice set perceived measures

Number of trips = 136

Site	Actual	Predicted
337	1.00	9.00
338	1.00	1.00
342	10.00	7.00
344	5.00	0.00
346	35.00	9.00
348	32.00	56.00
350	36.00	30.00
352	7.00	5.00
354	2.00	0.00
438	1.00	8.00
507	6.00	11.00

Examining model estimates beyond simple t-ratios and standard error magnitudes is necessary to fully assess a models predictive ability. The prediction success table is a good way to undertake such an examination. The results from the main data set model prediction success tables indicate that the RCP model has the highest PSI = 0.236 and the highest % CORR PRED = 30.61%. Also, the OS test results show that the RCP model has the highest PSI = 0.109 and % CORR PRED = 24.38%. These goodness of fit measures suggest that these types of models reduced choice set with perceived attribute measures, predict hunter site choice better than objective measure attribute full choice set models.

WELFARE ANALYSIS

Simulating Policy Scenarios

One important use of the above results is to examine simulations representing possible policy proposals. The simulations are achieved by altering levels of the site attributes and predicting which site(s) a moose hunter is expected to choose based on the hunter information (data) and estimated models.

Per trip welfare estimates were calculated from the regression results and the data set using equation (20) in Chapter 3. They represent the cost (-) or benefit (+) to a typical moose hunter (from this study) due to a specified resource change. Median welfare estimates are reported in Table 5-19.

TABLE 5-19
Welfare Measures

	Median Welfare Measures			
	Full Choice Set		Reduced Choice Set	
	objective	perceived	objective	perceived
Increase moose population at WMU 346	$25.95	$6.94	$30.03	$7.13
Close WMU 346	-$10.26	-$5.56	-$16.56	-$6.70
Decrease access at WMU 346	-$4.21	-$2.82	-$5.50	-$1.37

Three specific areas were targeted for simulations. Increasing moose population levels at WMU 346, simulating the site closure of WMU 346, and decreasing access at WMU 346. WMU 346 was one of the most frequently visited sites and was chosen for the simulations. The way in which the simulations were accomplished was to increase or decrease the quality attribute levels by one level (levels based on the opinion table).

The coefficients and directions of the signs (utilities) can be observed and compared to the resulting welfare estimates. Specifically the increase in utility and sign over the moose population coefficient range suggests a positive welfare estimate associated with an increase in moose populations. The access attribute sign direction (utility) is slightly different. For the objective measure models (1, 3) the positive sign (utility) associated with the restricted access level suggests that a decrease in access would provide a positive welfare estimate. For the perceived measure models (2, 4) a decrease in access would suggest a negative welfare estimate as the direction of the signs decrease over the range from positive at the high level access, to negative at the restricted level of access.

The first simulation was achieved by increasing each hunter's perception of current moose populations by one level. An example of this is that everyone who perceived a level 1 moose population level were now given a level 2. Everyone who chose level 4 remained at that level. Increasing moose populations at WMU 346 was selected for the simulation of improving moose numbers. The resulting per trip welfare estimates are: \$25.95, \$6.94, \$30.03, \$7.13 for Models 1, 2, 3, and 4 respectively and are positive as expected. The objective measure models produce significantly larger welfare estimates.

Simulating a site closure is accomplished by increasing the distance traveled to a site or by removing the site from the choice set. In this case the distance data was increased to 10,000 km, a distance that ensures a site choice probability equal to zero. WMU 346 was one of the most popular hunting sites and was chosen for this simulation. As expected, a negative welfare estimate results. By closing this site the impact (per trip cost) to an average hunter is -$10.26, -$5.56, -$16.56, -$6.70 for Models 1, 2, 3, and 4 respectively.

Access was regarded as an important attribute of moose hunting site quality. This was noted in the discussion period during the interviews as well as from the survey results. A restriction of access was implemented by lowering the stated level of access by one level. For individual's who chose the lowest (restricted) level, the value remained at that level. Decreasing access at 346 yields a negative welfare or a cost to the hunters in all four models. The estimates are -$4.21, -$2.82, -$5.50, and -$1.37 for Models 1, 2, 3, and 4 respectively.

Differences exist between the welfare estimates for each of the four models. From these few simulations it is impossible to generalize about the magnitude of the welfare estimates and the importance of the attributes in each model. However, some speculation as to the variation of estimates is possible.

The differences between welfare measures are greatest for the moose population simulation, followed by the site closure simulation and then the access simulation. This may indicate a pattern (of differences in magnitude) based on the importance of an attribute. Changes to moose populations at a site has a significant and direct impact on hunting in terms of bagging and hunting opportunity. If a site is closed, this will directly affect hunters but other sites are still available. And, if access is changed, the hunting may be altered at a site but still exist, perhaps a slightly less important issue or site choice indicator.

Some may expect the objective measure model estimates to be larger as they capture the actual (determined by experts) state or quality of the attributes. Others may expect the perceived measure models to yield higher estimates as they reflect the opinions and perceptions of the users themselves and this reflects the true value upon which hunters base their site choice decisions.

Some further observations show that of the perceived measure models, the reduced choice set welfare estimates are higher. For the objective measure models, the reduced choice set estimates are also greater. Furthermore, the perceived attribute model estimates are similar in magnitude to one another and also, the objective attribute model estimates are similar in magnitude.

However, if one is to analyze welfare estimates based on the results from earlier model performance tests, then the discussion would concentrate on estimates from the perceived measure model. These models indicated greater predictive ability based on both the main data set tests and the out of sample tests.

SUMMARY

This chapter contained a detailed discussion of the estimated models, various methods of measuring model performance, the results of these performance tests, and policy simulations generating welfare estimates

The random utility approach is based on comparisons of utility over attributes to predict hunter site choice. Examining changes in site attributes (simulating policy initiatives) allows for the calculation of welfare measures.

Specifically, whether or not the change in site quality results in a benefit or a loss. Four models were estimated, full choice set objective measures, full choice set perceived measures, reduced choice set objective measures, and reduced choice set perceived measures to examine behavioural linkages of site choice.

The following chapter will highlight the thesis results, discuss some of the current issues or questions relating to this thesis, and outline some direction for future research.

CHAPTER 6 - CONCLUSION

INTRODUCTION

In the past, many nonmarket valuation studies have excluded the issues of substitute sites and the incorporation of site quality characterisitcs. Since then, there have been several attempts to refine travel cost models by incorporating these characteristics. The intention of this thesis is to examine the incorporation of perceived environmental quality attributes into a discrete choice random utility travel cost model and examine how changes in these attribute levels affect an Alberta moose hunter's WMU choice.

STUDY FINDINGS

In this research, four RUM models were estimated, two using the full choice set data (FC), and two using the varying choice set data (VC). Each set of models included one model using objective attribute measures and the other model using perceived attribute measures. Also, the incorporation of perceived attribute measures was undertaken to examine another behavioural linkage to site choice. As discussed earlier, it is suggested that site choice is based on hunters perceptions of site quality and resulting expected utility.

The choice set distinction is interesting as it adds another link to choice behaviour. Current research argues that only sites of which an individual is aware would be considered as actual trip destinations and only those should be included in the choice set (Parsons and Kealy, 1992).

The question of which sites to include in a hunter's set of possible sites to visit is examined in this research. One option is to include all possible sites in the choice set. However, one can argue that all sites may not be potential sites to visit. The task is to develop a method of selecting sites to be included in a hunter's choice set. Since the author of this study is interested in perceptions of attribute levels, a site was included in the choice set if the hunter had indicated an opinion of the attribute level for each of the four attributes being examined: road quality, access, congestion, and moose populations.

Different statistical tests were employed to examine the performance of each of the four models. In initial summary t-ratio and standard error tests, the full choice set objective measure model performed the best. However, with more detailed analysis using Wald Tests, percent correct predictions, and prediction success indices, which are thought to be better indicators of model performance, the reduced choice set perceived measure model performs the best.

The resulting models revealed that perceptions of attributes play a role in predicting a hunter's site choice. Examining results from perceived attribute choice models provides another dimension of user preferences for use in decision-making. The policy maker is able to assess land-use decisions based on how the users perceive the quality of the area. However if one is to analyze welfare estimates based on the results from earlier model performance tests, then the discussion would concentrate on perceived measure estimates.

The welfare measures calculated are based on what people perceive the quality to be at the site. Thus these values better reflect how the users will be affected. Such welfare measures should be examined in conjunction with expert measures to see if a great difference exists. If a discrepency ocurrs, then perhaps more research needs to be undertaken to analyze the site quality and why the values differ. Also, decisions can and must be made using the best information available. In this study, the difference in welfare estimates was greatest for the moose population simulation, then the site closure simulation, and then by the decrease in access.

CURRENT ISSUES

This thesis has taken one approach to examining the method of incorporating perceived environmental quality measures. One main issue surrounding this approach is how to collect the perceptions data and in what form should the data exist.

"In-person" focus groups are time consuming, costly in terms of the individuals required for the data collection, and generally can only survey a small number of individuals. Other alternatives include: phone surveys, mail-out surveys, a combination of phone and mail-out surveys, or spot field surveys during the season. Issues of interviewer bias and non-response bias are a concern in telephone and mail-out surveys. Thus, some researchers are employing a combined mail-out and telephone survey where the background information and questionnaire are mailed out to the respondents in advance. Then, a telephone interview is scheduled to administer the questionnaire and address any issues or questions which the respondent may have regarding the background information or questionnaire.

Since perceptions information has not typically been gathered for resource planning, is there some way to forecast hunter site choice without perceptions information? How can welfare measures be generated if managers don't have this perceptions information? Perhaps more can be learned by examining the differences between objective measure models, perceived measure models, and reduced choice set models. This would require more policy simulations to see if a general pattern with respect to the magnitude of welfare estimates or direction of signs exists. One might argue that some environmental information is better than no information but that collecting representative (small group) perception data may not be harder than collecting objective attribute information. Thus managers will have to determine the information requirements and time available.

Another issue surrounds the transfer of information. Should managers work towards informing the users and public as to the present scientific (expert) quality levels which exist? Would this then suggest that the objective measure models represent the long term site choice or impacts and that the perceived measure models represent the short term impacts or current site choice? Would it even be possible or worthwhile to invest the time, money, and effort to transfer such information? Would managers pay more attention to informing users about the benefits and positive impacts from the changes or enhancements and not discuss the negative impacts or costs of certain activities/decisions? These questions cause concern if information transfer is to become a requirement.

The preceding discussion outlined some of the current issues arising from these types of nonmarket studies. The next section gives a brief description of some areas for future research and the complicated nature of the issues surrounding modeling site choice and incorporating perceptions within a random utility framework.

DIRECTIONS FOR FUTURE RESEARCH

Opportunity Cost Of Time

Recent literature proposes modifications to variables and models in an effort to incorporate the opportunity cost of time. Some argue that it takes time to travel and perhaps people take time off work for specific leisure activities, therefore there is a need to value time. Also, should on site time be counted or is this an implicit value in the activity itself? Fletcher et al. (1990) state that an individual's value for a workday may differ from that during the weekend.

In many instances, incorporating the opportunity cost of time is done in an *ad hoc* fashion. Two recent articles (Parsons & Needelman 1992, Parsons & Kealy 1992) add the opportunity cost of time = ({1/3 x (annual income÷2080) x travel time to and from the site} to their travel cost variable {0.10 x distance to and from the site}. Where 0.10 is the cost per mile of operating a car and 2080 is 40 hours per week multiplied by 52 weeks (in a year) which results in an average wage rate. The one third wage rate value for time is based on an *ad hoc* approach that some proportion of an individual's wage rate should be used rather than some constant, as the proportional value allows for variation across individuals (McConnell & Strand 1981).

McConnell and Strand (1981) develop a slightly more complicated and worthy method of valuing a recreation user's time. They propose to include a composite variable $a_i v_i$ in the regression analysis where a_i is the return trip distance divided by 45 miles per hour, or the round trip travel time, and v_i is the annual family income divided by 2080 (the number of hours worked in a year), or average hourly income (McConnell and Strand, 1981 p.154). An estimate of the opportunity cost of time is derived which yields the percentage of hourly income at which an individual values his/her time. This value would then be incorporated in the welfare, CV equation.[10]

If someone values time a great deal then it is clear that the value of a site near to them will be great, consequently if this site is closed then the loss will be large as they will have to travel farther to get to an alternate site.

Since we know that the opportunity cost of time is in effect a scaling of the welfare estimates, perhaps more research should be placed on the precision and validity of the welfare results. Once this is approved, methods of incorporating the opportunity cost of time can be examined. Therefore including the value of time is important in recreation studies.

Incorporating Demographic and Other Variables

Another issue to examine is the incorporation of demographic variables. As described in this research, these types of variables become irrelevant in the random utility analysis as the utility difference is calculated. These variables are constant at every site (since they characterize the individual) and thus drop out of the model. One way to address this issue is to create interaction terms, where demographic variables are interacted with other variables such as income or age through multiplication or division (ie. hunting experience ÷ age, distance x income, or by incorporating the opportunity cost of time as some portion of the wage rate). Modeling income specifically can complicate welfare estimates as the marginal utility of income would no longer be constant, and this is a main assumption for the CV equation derived in Chapter 3.

---

[10] Recall the CV formula, equation # 20, the mu would be multipled by k*individual income.

Another avenue for research is the development a good indicator of forestry activity. Perhaps the forestry variable (see Appendix 1, Opinion table for a description) could have been represented in three or four levels as the moose population and other variables were defined. This may be accomplished by outlining the various tree/stand classes or years of mature forest present within each WMU.

Modeling Techniques

A third avenue of research concerns modeling techniques. Is the random utility framework the only method available for examination of travel cost models incorporating quality effects? Do other issues require further investigation? One method of exploring the nature of perceived attribute measure variables is using a Latent Variable Approach, also termed error-in-variable or measurement error. The above approach is based on the assumption that there is some error in obtaining the perceived quality data, or observation error.

Luzar *et al.* state that "quality can be conceptualized as a latent variable which is unobservable but is reflected through other attributes, properties, or characteristics" (p. 107). This latent variable approach allows an examination of the contributors to quality through a simultaneous equation process. The first equation describes travel cost as a function of variables influencing cost such as spatial factors, services available, and quality, and the second equation describes quality as a function of variables influencing quality such as biological factors, skill, effort, and price (Luzar *et al.* 1992). Ben-Akiva and Lerman state that one of the random utility model's sources of randomness can in fact be measurement errors (1985 p.57). Therefore, the RUM approach is one way to model perceptions, if perceptions are seen as unobservable variables, or the latent variable framework can also be employed.

Other linkages to investigate include other socio-economic or behavioural variables which examine attitudes, habit formation (and resulting models), learning, and information effects. Most of these issues are addressed in social-psychology and business literature.

A specific issue to examine is the method(s) of incorporating learning into site choice and choice set size. The random utility model defined in this research is incapable of dealing with the dynamic nature of site choice and the impacts of learning and experience on choice set size. An individual's opinion of the expected utility associated with visiting a site is based on information, visits, or other dynamic criteria. If any of these criteria change, an individual's opinion of that site may change. If the information or stimuli is negative then they may choose not to visit the site or simply exclude it from their choice set. Other models should be examined to address these issues.

Limitations

Incorporating perceptions of site quality is a relatively new concept. Interesting linkages are being examined as well as limitations to different modeling techniques. One main issue surrounding the random utility framework is that the number of trips remains constant in the analysis.

Specifically when examining policy simulations, there is no mechanism to allow for the option of not visiting a site if the attributes change. Therefore this behavioural linkage is missing.

Another issue relating to welfare measures is the way in which the simulations are accomplished. In this research, increasing or decreasing the attribute level is chosen to simulate an impact. However, if the attribute is already at the lowest level, in the case of a decrease, that level would not be altered. Thus those responses are really not affected. The reverse ocurrs for the increase in attribute level. Other methods of simulating attribute changes need to be examined further.

CONCLUDING REMARKS

This research is another attempt to examine ways of determining a value of recreation. Incorporating perceptions of site quality is relatively new and is a promising avenue for future research. In the case of recreational moose hunting, incorporating perceptions of attribute quality in the random utility model is a step forward in examining the behavioural linkages of recreation site choice. The results from this research confirm that there is more research to be done regarding model structure and modeling techniques, demographic linkages, incorporating the opportunity cost of time, and exploring interdisciplinary approaches.

These types of studies are undertaken to address public interest, government policy, and environmental concern. Society is recognizing the need for effective resource planning for environmental and social sustainability. Studies examining the impacts of changes to environmental quality are the stepping stones for environmental, regional, and social policy development.

Bibliography

Adamowicz, W. L. 1991. Valuation of Environmental Amenities. Staff Paper 91-06. Department of Rural Economy, University of Alberta. Edmonton.

Bockstael, N. E., W. M. Hanemann, and C. L. Kling. 1987. Estimating the Value fo Water Quality Improvements in a Recreational Demand Framework. *Water Resources Research* 23(5):951-960.

Braden, J. B. and C. D. Kolstad. 1991. *Measuring the Demand for Environmental Quality.* New York: North-Holland.

Brown, J. J. and A. R. Wildt. 1992. Consideration Set Measurement. *Journal of the Academy of Marketing Science* 20(3):235-243.

Brush, R. O. 1976. Perceived Quality of Scenic and Recreational Environments Some Methodological Issues. In *Perceiving Environmental Quality: Research and Applications.* New York: Plenum Press.

Cameron, T. A. 1988. The Determinants of Value for a Marine Estuarine Sportfishery: The effect of Water Quality in Texas Bays. Paper presented at the AERE Workshop, University of Washington, Seattle, WA, June 22-23.

Clawson, M. and J. L. Knetsch. 1966. *Economics of Outdoor Recreation.* Baltimore: John Hopkins Press for Resources for the Future.

Craik, K. E. and E. H. Zube (eds). 1976. *Perceiving Environmental Quality: Research and Applications.* New York: Plenum Press.

Cutter, S. L. 1985. *Rating Places: A Geographer's View on Quality of Life.* Washington: Association of American Geographers.

El Serafy, S. and E. Lutz. 1989. Environmental and Resource Accounting: An Overview. In *Environmental Accounting for Sustainable Development.*, ed. Y. J. Ahmad, S. El Serafy, E. Lutz. Washington: The World Bank.

Englin, J. and R. Mendelsohn. 1991. A Hedonic Travel Cost Analysis for Valuation of Multiple Components of Site Quality: The Recreation Value of Forest Management. *Journal of Environmental Economics and Management.* 21:119-147.

Fletcher, J. J., W. L. Adamowicz, and Theodore Graham-Tomasi. 1990. The Travel Cost Model of Recreation Demand: Theoretical and Empirical Issues. *Leisure Sciences* 12:119-147.

Freeman, A. M. III. 1979. *The Benefits of Environmental Improvement: Theory and Practice.* Baltimore: The Johns Hopkins University press for Resources for the Future, Inc.

Freeman, A. M. III, R. H. Haveman, and A. V. Kneese. 1973. *The Economics of Environmental Policy.* New York: John Wiley & Sons, Inc.

Gravelle, H. and R. Rees. 1992. *Microecnomics.* 2nd ed. New York: Longman Publishing.

Gould, P. E. and R. White. 1986. *Mental Maps.* Boston: Allen and Unwin.

Hanemann, W. M. 1994. Valuing the Environment Through Contingent Valuation. *Jouranl of Economic Perspectives.* 8(4):19-43.

Hausman, J. A. (ed). 1993. *Contingent Valuation: A Critical Assessment.* Amsterdam: North-Holland.

Heberlein, T. A. 1988. Economics and Social Psychology in Amenity Valuation. In *Amenity Resource Valuation: Integrating Economics with Other Disciplines.* 235-244. State College: Venture Publishing, Inc.

Horowitz, J. L. and J. J. Louviere. 1993. Testing Predicted Choices Against Observations in Probabilistic Discrete Choice Models. *Marketing Science* 12(3):270-279.

Judge, G. G., R. C. Hill, W. E. Griffiths, H. Lütkepohl, T-C. Lee. 1982. *Introduction to the Theory and Practice of Econometrics.* 2nd ed. New York: John Wiley and Sons, Inc.

Kennedy, P. 1989. *A Guide to Econometrics.* Cambridge: The MIT Press.

Kopp, R. J. and V. K. Smith. 1993. Implementing Natural Resource Damage Assessments. In*Valuing Natural Assets The Economics of Natural Resource Damage Assessment,* ed. Raymond J Kopp and V. Kerry Smith. Washington: Resources for the Future.

Leiber, S. R., D. R. Fesenmaier, and R. S. Bristow. 1988. Social and Environmental Characteristics Affecting Design Alternatives for Outdoor Recreation Participation. In *Behavioural Modelling in Geography and Planning*, ed. R. G. Golledge and H. Timmermans. New York: Croom Helm.

Louviere, J. J. 1988. *Analyzing Decision Making Metric Conjoint Analysis*. Sage University Paper Series on Quantitative Applications in the Social Sciences, series no. 07-067. Newbury Park, CA: Sage Publications, Inc.

Luzar, E. J., C. Gan, B. Kanjilal, and M. Messoniier. 1992. Quality as a Latent Varible in Recreation Access Analysis. *Southern Journal of Agricultural Economics*. December: 105-112.

Maddala, G.S. 1983. *Limited-Dependent and Qualitative Variables in Econometrics*. New York: Cambridge University Press.

Mitchell, R. C. and R. T. Carson. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method.* Washington, DC: Resources for the Future.

McComb, W. C., T. A. Spies, and W. H. Emmingham. 1993. Douglas-Fir Forests: Managing for Timber and Mature Forest Habitat. *Journal of Forestry*. 91(12):31-42.

McConnell, K. E. and I. Strand. 1981. Measuring the Cost of Time in Recreation Demand Analysis: An application to Sportfishing. *American Journal of Agricultural Economics*. 63(1): 153-156.

McLeod, K. N., P. C. Boxall, W. L. Adamowicz, M. Williams, and J. J. Louviere. 1993. The Incorporation of Nontimber Goods and Services in Integrated Resource Management. I. An Introduction to the Alberta Moose Hunting Study Interim Project Report. Project Report No. 93-12. Department of Rural Economy, University of Alberta. Edmonton.

Mehrotra, S. and J. Palmer. 1985. Relating Product Quality Features to Perceptions of Quality: Appliances. In *Perceived Quality: How consumers View Stores and Merchandise*, ed. J. Jacoby and J. C. Olson. Toronto: DC Heath & Company.

Mercer, D. 1971. The role of Perception in the Recreation Experience: A Review and Discussion. *Journal of Leisure Research.* 3(4): 261-276.

Parsons, G. R. and M. Kealy. 1992. Randomly Drawn Opportunity Sets in a Random Utility Model of Lake Recreation. *Land Economics*. 68(1): 93-106.

Parsons, G. R. and M. S. Needelman. 1992. Site Aggregation in Recreation. *Land Economics*. 68(4): 418-433.

Pearse, P. H. 1990. *Introduction to Forestry Economics*. Vancouver: The University of British Columbia Press.

Perdue, R. R. 1987. The Influence of Awareness on Spatial Behaviour in Recreational Boating. *Leisure Sciences*. 9: 15-25.

Peters, T. L. 1993. *A Random Utility Analysis of Southern Alberta Sportfishing*. Unpublished M.Sc. thesis. Department of Rural Economy, University of Alberta, Edmonton.

Prewitt, R. A. 1949. *The Economics of Public Recreation. An Economic Survey of the Monetary Evaluation of Recreation in the National Parks*. Washington: National Parks Service (mimeo).

Repetto, R. 1993. How to Account for Environmental Degredation. In *Forestry and the Environment: Economic Perspectives*, ed. W. L. Adamowicz, W. White and W. E. Phillips. Wallingford, UK: C·A·B International.

Schiff, M. R. 1970. The Definition of Perceptions and Attitudes. In *Perceptions and Attitudes in Resource Management*, ed. W. R. D. Sewell and I. Burton. Resource Paper No. 2, Policy Research and Coordination Branch. Department of Energy, Mines and Resources, Ottawa, Canada.

Shelby, B., J. J. Vaske, and T. A. Heberlein. 1989. Comparative Analysis of Crowding in Multiple Locations: Results from Fifteen Years of Research. *Leisure Sciences*. 11(4): 269-291.

Small, K. A. and H. S. Rosen. 1981. Applied Welfare Economics with Discrete Choice Models. *Econometrica* 49

Smith, V. K. 1989. Taking Stock of Progress with Travel Cost Recreation Demand Methods: Theory and Implementation. *Marine Resource Economics*. 6: 279-310.

Smith, V. K. 1993. Nonmarket Valuation Of Environmental Resources: An Interpretive Appraisal. *Land Economics* 69(1): 1-26.

Smith, V. K. and W. H. Desvousges. 1986. *Measuring Water Quality Benefits*. Boston: Kluwer-Nijhoff Publishing.

Stynes, D. J., D. M. Spotts, and J. R. Strunk. 1985. Relaxing assumptions of perfect information in park visitation models. *Professional Geographer.* 37(1): 21-28.

Train, K. 1986. *Qualitative Choice Models.* Cambridge: MIT Press.

White, Gilbert F. 1966. Formation and Role of Public Attitudes. In *Environmental Quality in a Growing Economy,* ed. H. Jarrett. Resources for the Future, Baltimore: The John Hopkins Press.

APPENDIX 1

Alberta Moose Hunting Study

Sponsored by the University of Alberta and Forestry Canada

MOOSE HUNTING IN ALBERTA

The following questions ask about the characteristics of your moose hunting trips, experience, and travel preferences. Your answers are important as they will help us understand hunting preferences for more effective management of wildlife and resources.

1. Which WMU is your preferred moose hunting area? ____________

2. Have you ever hunted moose in the following Wildlife Management Units (WMU's)? (please check all that apply)

   ☐ 337
   ☐ 338
   ☐ 340
   ☐ 342
   ☐ 344
   ☐ 346
   ☐ 348
   ☐ 350
   ☐ 352
   ☐ 354
   ☐ 356
   ☐ 437
   ☐ 438
   ☐ 439
   ☐ 507

3 How many years of general hunting experience do you have? ________ years (enter number)

4. How many years have you been hunting moose? ________ years (enter number)

5. Do you typically go moose hunting alone or with other hunters? (please check one)

   ☐ Alone
   ☐ with one or two other people
   ☐ with three to five other people
   ☐ with five or more people

6. What type of transportation do you usually use to go **from your home to a moose hunting site**? (Please check one)

   ☐ two-wheel drive highway vehicle
   ☐ four-wheel drive highway vehicle
   ☐ camper/RV
   ☐ horse
   ☐ other (please specify) ____________________

7. **While hunting** on your typical hunting trip in 1992, did you? (please check all that apply)

   ☐ Use a two-wheel drive vehicle
   ☐ Use a four-wheel drive vehicle
   ☐ Use a trail bike or ATV
   ☐ Hunt on foot
   ☐ Use horses
   ☐ Use a snowmobile
   ☐ other (please specify) ______________

We would like to ask a few questions about you that will tell us about people who participate in hunting moose in Alberta. Strict confidentiality will be maintained, and your responses will be used only for academic research purposes.

8. Where do you live? (nearest city or town): ____________________________

9. Are you: ☐ Male ☐ Female

10. What is your age? ______ years

11. Please indicate the highest level of education that you have completed.

☐ elementary/jr. high (grades 1 to 9)
☐ high school (grades 10 to 12)
☐ post secondary school (certificate, diploma, degree)
☐ graduate degree

12. Which of the following categories best represents your **total 1992 household income before taxes?** (please check one)

☐ $0 - $20,000	☐ $20,001 - $40,000	☐ $40,001 - $60,000
☐ $60,001 - $80,000	☐ $80,001 - $100,000	☐ Over $100,000

13. Could you be working on the days that you take hunting trips? ☐ Yes ☐ No

14. Do you use some or all of your vacation time when you go hunting? ☐ Yes ☐ No

15. Please rank each of the following reasons for moose hunting from 1 to 3, where 1 is the most important reason and 3 is the least important reason.

Rank
___ Shooting a trophy moose
___ Putting meat in the freezer
___ Companionship of friends/family/relatives

16. Please rank each of the following events according to the amount it detracts from your moose hunting enjoyment from 1 to 3, where 1 is the most detracting and 3 is the least detracting.

Rank
___ Hearing shots and voices or seeing other hunters
___ Hunters other than those in my hunting party
___ Hearing the sound of off-highway vehicles

Recent Moose Hunting Trip Descriptions

Recent Moose Hunting Trip Descriptions

Please complete the following information for each moose hunting trip that you took during the 1992 hunting season.

Trip No.	Distance from Home to Site (in km one way and travel time in hours)	WMU that you hunted in on this trip	Dates that you hunted in this WMU	Have you hunted in this WMU prior to 1992	Number of Individuals in Hunting Party	Length of Trip (days)	Moose shot by Yourself and Total by Your Party	Type of Accommodation eg: tent/trailer/RV, outdoors/campground, cabin, lodge, motel, n/a. tents, camp outdoors
For Example →	90 km, 1 hr	350	Nov. 12 - 15	yes	5	4 days	0 moose myself, 2 moose party	Tent
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

If you need additional pages to record all your moose hunting trips notify one of the study officials present at the meeting.

Opinions About Wildlife Management Units

Opinions About WMUs

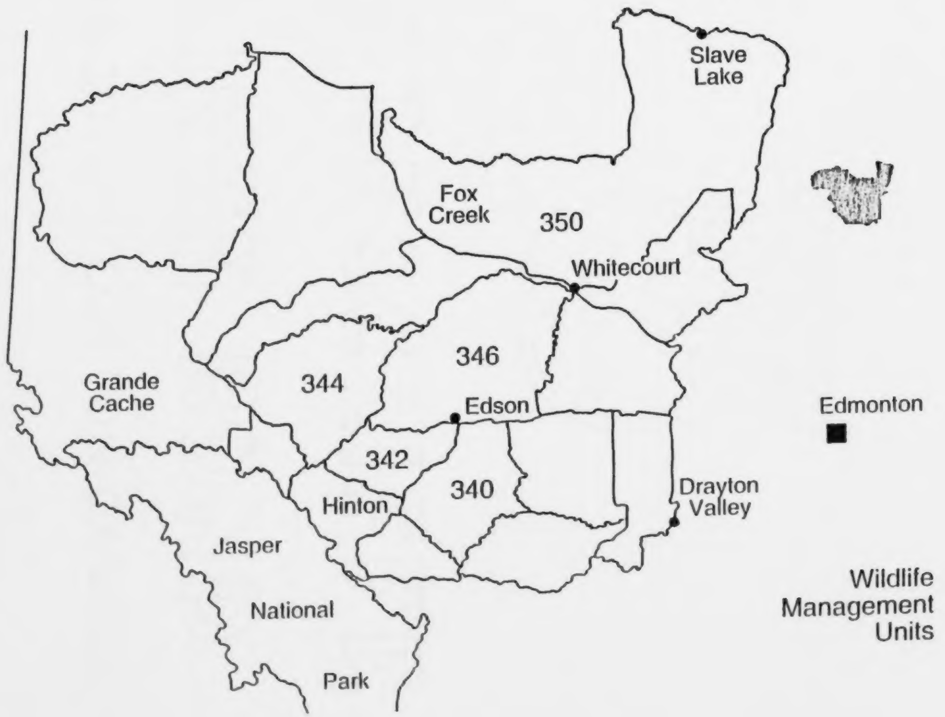
In this section we would like you to tell us which characteristics (as described in the Glossary of Terms) best describe each Wildlife Management Unit listed below. Do this by checking one box for each characteristic (distance, quality of road, etc.) in each column. For example, if you think WMU 777 is 50km away, the roads are mostly paved, you don't know about access, other hunters in trucks are encountered, no evidence of logging and evidence of 3 moose per day. You would indicate this as shown under WMU 777. Now, please indicate the characteristics which best describe the other 15 WMUs by checking the most appropriate boxes in each column.

	Wildlife Management Units							
Characteristics:	**777**	**337**	**338**	**340**	**342**	**344**	**346**	**348**
I. Distance From Your Home to Possible Hunting Areas:								
50 km	☑	☐	☐	☐	☐	☐	☐	☐
150 km	☐	☐	☐	☐	☐	☐	☐	☐
250 km	☐	☐	☐	☐	☐	☐	☐	☐
350 km	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
II. Quality of the Road From Your Home to Hunting Areas:								
Mostly paved, some gravel or dirt	☑	☐	☐	☐	☐	☐	☐	☐
Mostly gravel or dirt, some paved	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
III. Access Within These Hunting Areas:								
No trails, cutlines or seismic lines	☐	☐	☐	☐	☐	☐	☐	☐
Old trails,cutlines or seismic ines,not passable without ATV	☐	☐	☐	☐	☐	☐	☐	☐
Newer trails, cutlines or seismic lines, passable with a 4WD	☐	☐	☐	☐	☐	☐	☐	☐
Newer trails, cutlines or seismic lines, passable with 2 WD	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☑	☐	☐	☐	☐	☐	☐	☐
IV. Encountering Other Hunters, During the Course of a Hunting Day, in the Hunting Areas:								
No hunters, other than my hunting party, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, hunting on foot, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, on ATV's, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, in trucks, are encountered	☑	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
V. Forestry Operations in Your Hunting Areas:								
No evidence of logging	☑	☐	☐	☐	☐	☐	☐	☐
Some evidence of recent logging found in the area	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
VI. Moose Populations in These Hunting Areas:								
Evidence of less than 1 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
Evidence of 1 or 2 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
Evidence of 3 moose per day	☑	☐	☐	☐	☐	☐	☐	☐
Evidence of more than 4 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐

Opinions About WMUs - continued

	Wildlife Management Units							
Characteristics:	**350**	**352**	**354**	**356**	**437**	**438**	**439**	**507**
I. Distance From Your Home to Possible Hunting Areas:								
50 km	☐	☐	☐	☐	☐	☐	☐	☐
150 km	☐	☐	☐	☐	☐	☐	☐	☐
250 km	☐	☐	☐	☐	☐	☐	☐	☐
350 km	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
II. Quality of the Road From Your Home to Hunting Areas:								
Mostly paved, some gravel or dirt	☐	☐	☐	☐	☐	☐	☐	☐
Mostly gravel or dirt, some paved	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
III. Access Within These Hunting Areas:								
No trails, cutlines or seismic lines	☐	☐	☐	☐	☐	☐	☐	☐
Old trails,cutlines or seismic ines,not passable without ATV	☐	☐	☐	☐	☐	☐	☐	☐
Newer trails, cutlines or seismic lines, passable with a 4WD	☐	☐	☐	☐	☐	☐	☐	☐
Newer trails, cutlines or seismic lines, passable with 2 WD	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
IV. Encountering Other Hunters, During the Course of a Hunting Day, in the Hunting Areas:								
No hunters, other than my hunting party, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, hunting on foot, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, on ATV's, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, in trucks, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
V. Forestry Operations in Your Hunting Areas:								
No evidence of logging	☐	☐	☐	☐	☐	☐	☐	☐
Some evidence of recent logging found in the area	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
VI. Moose Populations in These Hunting Areas:								
Evidence of less than 1 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
Evidence of 1 or 2 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
Evidence of 3 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
Evidence of more than 4 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐

Figure 1: Map of the Study Area Wildlife Management Units


Slave Lake
Fox Creek
350
Whitecourt
346
344
Grande Cache
Edson
Edmonton
342
340
Hinton
Drayton Valley
Jasper
National
Park
Wildlife Management Units

Source: Canadian Forest Service, 1992

APPENDIX 2

Alberta Moose Hunting Study Participation Rates

Town	Total Contacts by Telephone	Total Who Agreed to Attend	Total That Acutally Attended	% Who Agreed That Actually Attended
Whitecourt	94	67	52	78
Edson	79	60	51	85
Hinton	50	39	31	79
Drayton Valley	36	30	25	83
Edmonton	163	116	112	97

APPENDIX 3

Opinions About WMUs

In this section we would like you to tell us which characteristics (as described in the Glossary of Terms) best describe each Wildlife Management Unit listed below. Do this by checking one box for each characteristic (distance, quality of road, etc.) in each column. For example, if you think WMU 777 is 50km away, the roads are mostly paved, you don't know about access, other hunters in trucks are encountered, no evidence of logging and evidence of 3 moose per day. You would indicate this as shown under WMU 777. Now, please indicate the characteristics which best describe the other 15 WMUs by checking the most appropriate boxes in each column.

Wildlife Management Units

Characteristics:	**777**	**337**	**338**	**340**	**342**	**344**	**346**	**348**
I. Distance From Your Home to Possible Hunting Areas:								
50 km	☑	☐	☐	☐	☐	☐	☐	☐
150 km	☐	☐	☐	☐	☐	☐	☐	☐
250 km	☐	☐	☐	☐	☐	☐	☐	☐
350 km	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
II. Quality of the Road From Your Home to Hunting Areas:								
Mostly paved, some gravel or dirt	☑	☐	☐	☐	☐	☐	☐	☐
Mostly gravel or dirt, some paved	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
III. Access Within These Hunting Areas:								
No trails, cutlines or seismic lines	☐	☐	☐	☐	☐	☐	☐	☐
Old trails,cutlines or seismic ines,not passable without ATV	☐	☐	☐	☐	☐	☑	☑	☐
Newer trails, cutlines or seismic lines, passable with a 4WD	☐	☑	☑	☐	☐	☐	☐	☑
Newer trails, cutlines or seismic lines, passable with 2 WD	☐	☐	☐	☑	☑	☐	☐	☐
I don't know	☑	☐	☐	☐	☐	☐	☐	☐
IV. Encountering Other Hunters, During the Course of a Hunting Day, in the Hunting Areas:								
No hunters, other than my hunting party, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, hunting on foot, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, on ATV's, are encountered	☐	☐	☐	☐	☐	☐	☐	☑
Other hunters, in trucks, are encountered	☑	☑	☑	☑	☑	☑	☑	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
V. Forestry Operations in Your Hunting Areas:								
No evidence of logging	☑	☐	☐	☐	☐	☐	☐	☐
Some evidence of recent logging found in the area	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
VI. Moose Populations in These Hunting Areas:								
Evidence of less than 1 moose per day	☐	☐	☐	☐	☑	☑	☐	☐
Evidence of 1 or 2 moose per day	☐	☑	☐	☑	☐	☐	☐	☐
Evidence of 3 moose per day	☑	☐	☑	☐	☐	☐	☑	☐
Evidence of more than 4 moose per day	☐	☐	☐	☐	☐	☐	☐	☑
I don't know	☐	☐	☐	☐	☐	☐	☐	☐

Opinions About WMUs - continued

	Wildlife Management Units							
Characteristics:	**350**	**352**	**354**	**356**	**437**	**438**	**439**	**507**
I. Distance From Your Home to Possible Hunting Areas:								
50 km	☐	☐	☐	☐	☐	☐	☐	☐
150 km	☐	☐	☐	☐	☐	☐	☐	☐
250 km	☐	☐	☐	☐	☐	☐	☐	☐
350 km	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
II. Quality of the Road From Your Home to Hunting Areas:								
Mostly paved, some gravel or dirt	☐	☐	☐	☐	☐	☐	☐	☐
Mostly gravel or dirt, some paved	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
III. Access Within These Hunting Areas:								
No trails, cutlines or seismic lines	☐	☐	☐	☐	☐	☐	☐	☐
Old trails,cutlines or seismic ines,not passable without ATV	☑	☑	☑	☐	☑	☐	☑	☐
Newer trails, cutlines or seismic lines, passable with a 4WD	☐	☐	☐	☑	☐	☑	☐	☐
Newer trails, cutlines or seismic lines, passable with 2 WD	☐	☐	☐	☐	☐	☐	☐	☑
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
IV. Encountering Other Hunters, During the Course of a Hunting Day, in the Hunting Areas:								
No hunters, other than my hunting party, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, hunting on foot, are encountered	☐	☐	☐	☐	☐	☐	☐	☐
Other hunters, on ATV's, are encountered	☐	☑	☑	☐	☑	☑	☐	☐
Other hunters, in trucks, are encountered	☑	☐	☐	☑	☐	☐	☑	☑
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
V. Forestry Operations in Your Hunting Areas:								
No evidence of logging	☐	☐	☐	☐	☐	☐	☐	☐
Some evidence of recent logging found in the area	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐
VI. Moose Populations in These Hunting Areas:								
Evidence of less than 1 moose per day	☐	☑	☐	☐	☐	☐	☑	☐
Evidence of 1 or 2 moose per day	☑	☐	☑	☑	☑	☑	☐	☑
Evidence of 3 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
Evidence of more than 4 moose per day	☐	☐	☐	☐	☐	☐	☐	☐
I don't know	☐	☐	☐	☐	☐	☐	☐	☐

APPENDIX 4

Frequency of Moose Hunter Perceptions and Objective Measures of Moose Populations at WMUs in Alberta

WMU	Obejctive measures by F & W * Division	Hunter Perceptions of Moose Populations in These Areas Evidence of Moose per day				total who responded 1 - 4	responded "I don't know"
		1 less than 1 moose	2 1 or 2 moose	3 3 moose	4 more than 4 moose		
337	2	40	36	8	7	91	122
338	3	47	48	11	12	118	95
340	2	48	49	12	7	116	98
342	1	48	37	9	1	95	115
344	1	51	27	13	4	95	122
346	3	61	61	32	19	173	59
348	4	46	34	21	21	122	94
350	2	56	68	19	19	162	82
352	1	46	46	22	10	124	103
354	2	31	34	17	8	90	131
356	2	16	23	14	5	58	156
437	2	27	22	7	4	60	154
438	2	36	17	8	6	67	146
439	1	34	10	3	3	50	161
507	2	27	31	8	10	76	142

* Note F & W is the Alberta Fish & Wildlife division

Frequency of Moose Hunter Perceptions and Objective Measures of Congestion at WMUs in Alberta

WMU	Obejctive measures by F & W * Division	Hunter Perceptions of Congestion in These Areas Encountering hunters during the course of a day				total who responded 1 - 4	responded "I don't know"
		1 my party only	2 hunters on foot	3 hunters on ATV's	4 hunters in trucks		
337	4	4	10	33	61	108	111
338	4	6	12	39	79	136	85
340	4	2	10	41	75	128	91
342	4	6	11	39	56	112	101
344	4	9	6	47	53	115	103
346	4	8	10	73	94	185	48
348	3	5	18	49	75	147	73
350	4	7	10	72	82	171	72
352	3	7	8	55	66	136	92
354	3	3	8	52	40	103	119
356	4	6	2	28	28	64	150
437	3	4	15	20	33	72	143
438	3	6	13	19	39	77	136
439	4	7	16	14	28	65	149
507	4	10	8	28	38	84	135

* Note F & W is the Alberta Fish & Wildlife division

Frequency of Moose Hunter Perceptions and Objective Measures of Access at WMUs in Alberta

WMU	Obejctive measures by F & W * Division	Hunter Perceptions of Access in These Areas Amount of Access				total who responded 1 - 4	responded "I don't know"
		1 no trails, cutlines or seismic lines	2 old trails ATV use only	3 newer trails passable with 4WD	4		
337	3	4	42	47	19	112	105
338	3	0	65	63	14	142	77
340	4	4	60	65	11	140	79
342	4	3	45	56	15	119	96
344	2	1	55	56	15	127	95
346	2	2	80	77	29	188	46
348	3	3	69	54	21	147	71
350	2	1	84	73	19	177	69
352	2	2	70	60	20	152	78
354	2	1	55	50	11	117	108
356	3	3	35	32	7	77	142
437	2	0	49	29	9	87	134
438	3	1	45	34	10	90	129
439	2	4	37	26	6	73	146
507	4	2	39	37	16	94	129

* Note F & W is the Alberta Fish & Wildlife division

APPENDIX 5

TABLE 5-7

PREDICTION SUCCESS TABLE: FULL CHOICE SET OBJECTIVE MEASURES

		Predicted choice														Observed count
	SITE	337	338	340	342	344	346	348	350	352	354	356	437	438	507	
	337	15.19	13.22	6.31	2.99	3.72	13.44	11.52	8.55	0.69	0.41	0.21	1.33	0.47	6.95	85.00
	338	12.14	12.15	7.92	3.80	3.54	20.67	10.54	8.00	1.07	0.36	0.23	1.51	0.46	5.61	88.00
	340	4.45	7.77	8.30	4.95	10.49	33.02	8.17	6.49	1.67	0.41	0.49	2.88	1.49	3.42	94.00
	342	1.32	3.47	3.48	2.67	15.74	21.14	3.21	2.46	1.06	0.61	0.60	3.10	2.23	0.90	62.00
	344	1.47	2.73	2.22	1.88	11.41	14.30	2.92	2.42	0.73	0.46	0.44	2.23	1.62	1.18	46.00
Observed	346	11.53	23.31	22.06	13.03	14.42	79.74	29.75	35.62	5.34	2.06	1.17	5.47	2.05	12.45	258.00
choice	348	7.58	12.09	5.30	4.47	4.99	19.96	20.70	30.72	2.56	1.96	0.67	1.81	0.71	10.48	124.00
	350	14.59	15.08	6.90	5.75	5.21	24.56	23.60	25.34	1.90	0.96	0.49	2.25	0.74	14.64	142.00
	352	1.62	2.45	1.93	1.24	1.43	7.05	3.34	3.75	0.47	0.19	0.11	0.53	0.20	1.67	26.00
	354	2.81	2.60	1.31	1.05	0.92	4.64	3.86	3.33	0.25	0.05	0.06	0.41	0.13	2.58	24.00
	356	1.72	1.67	0.76	0.65	0.83	2.86	2.58	2.52	0.19	0.08	0.06	0.29	0.12	1.66	16.00
	437	0.27	0.54	0.66	0.35	0.34	2.32	0.54	0.43	0.12	0.01	0.02	0.14	0.05	0.21	6.00
	438	0.02	0.05	0.05	0.04	0.29	0.33	0.04	0.03	0.02	0.01	0.01	0.05	0.04	0.01	1.00
	507	1.25	1.88	0.79	0.68	0.68	2.94	3.24	4.73	0.38	0.29	0.10	0.26	0.10	1.68	19.00
Predicted count		75.95	99.01	68.00	43.56	74.00	246.99	124.00	134.41	16.44	7.88	4.65	22.28	10.40	63.44	

total observed 991.0
total predicted 991.0

PSI = 0.05025
MAX PSI = .8706
% CORR PRED = .1795

TABLE 5-8
PREDICTION SUCCESS TABLE: FULL CHOICE SET PERCEIVED MEASURES

		Predicted choice														Observed count
	SITE	337	338	340	342	344	346	348	350	352	354	356	437	438	507	
	337	30.19	13.89	5.06	3.61	1.71	7.87	4.82	5.61	2.39	1.20	0.28	0.26	2.57	5.54	85.00
	338	16.91	19.35	8.83	3.53	1.20	12.47	8.45	4.75	2.70	1.16	0.24	2.37	2.33	3.70	88.00
	340	3.46	10.38	19.92	6.34	5.39	14.53	7.54	5.05	3.64	1.02	0.48	6.66	6.26	3.32	94.00
	342	0.63	3.11	5.32	9.12	28.11	4.58	1.37	1.21	0.85	0.49	0.48	1.79	2.55	2.39	62.00
	344	1.02	0.73	4.33	2.73	6.65	6.41	1.67	3.39	2.51	1.46	0.80	3.05	6.67	4.57	46.00
Observed	346	14.06	13.94	34.58	14.16	7.94	58.79	48.46	21.21	11.32	5.11	1.04	5.72	7.62	14.04	258.00
choice	348	2.60	2.52	3.85	3.36	1.79	11.08	55.93	16.78	5.05	4.49	0.38	1.67	1.55	12.94	124.00
	350	10.63	8.04	5.57	5.74	3.31	17.06	24.71	36.28	6.72	2.49	0.74	1.80	1.69	17.24	142.00
	352	1.13	2.53	2.62	1.19	0.68	4.31	4.36	3.60	2.34	0.43	0.09	0.62	0.49	1.60	26.00
	354	2.01	2.46	1.19	1.34	1.22	2.72	1.67	3.45	1.45	0.47	0.30	4.08	0.37	1.27	24.00
	356	0.41	1.04	0.50	0.93	1.67	0.87	2.45	1.99	0.91	0.41	0.29	3.60	0.21	0.72	16.00
	437	0.39	0.53	1.16	0.44	0.10	0.74	0.45	0.10	0.10	0.03	0.01	1.05	0.85	0.05	6.00
	438	0.00	0.00	0.13	0.01	0.02	0.57	0.00	0.01	0.05	0.02	0.01	0.00	0.13	0.07	1.03
	507	0.34	0.25	0.69	0.49	0.28	2.38	5.06	1.64	0.71	0.54	0.06	0.12	0.12	6.31	19.00
Predicted count		83.779	78.781	93.759	52.980	60.084	144.37	166.94	105.07	40.756	19.322	5.1795	32.784	33.413	73.786	

total observed 991.02
total predicted 991.02

PSI = .14939
MAX PSI = 0.9003
% CORR PRED = .24906

TABLE 5-9

PREDICTION SUCCESS TABLE: REDUCED CHOICE SET OBJECTIVE MEASURES

		Predicted choice														Observed count
	SITE	337	338	340	342	344	346	348	350	352	354	356	437	438	507	
	337	31.39	20.43	4.74	2.17	1.78	6.33	4.00	3.14	0.44	0.19	0.03	0.20	0.05	2.13	77.00
	338	9.10	16.08	10.35	3.85	2.44	20.85	8.68	8.39	1.33	0.50	0.17	1.33	0.37	3.54	87.00
	340	3.87	7.89	11.47	7.10	9.21	33.09	5.48	3.84	1.86	0.48	0.41	2.44	1.10	1.77	90.00
	342	1.09	3.68	4.74	3.97	13.33	21.84	3.12	2.24	1.19	0.74	0.53	2.83	1.85	0.85	62.00
	344	0.43	1.82	2.49	2.28	10.78	15.64	1.76	3.81	0.82	0.55	0.32	1.63	1.23	0.43	44.00
Observed	346	6.89	18.92	24.94	15.37	12.45	86.84	33.85	27.80	6.44	1.98	1.03	4.81	1.73	10.95	254.00
choice	348	2.78	6.99	4.25	3.85	3.29	15.28	37.71	33.89	2.22	1.69	0.47	1.17	0.44	6.96	121.00
	350	9.36	15.46	6.71	6.75	4.26	23.34	15.65	32.22	2.73	1.10	0.46	0.99	0.34	9.64	129.00
	352	0.86	2.00	2.23	1.56	1.33	6.90	2.68	4.99	0.84	0.23	0.09	0.34	0.15	0.80	25.00
	354	1.65	2.06	1.34	1.15	0.87	3.75	2.61	2.40	0.31	1.00	1.14	0.38	0.12	2.22	21.00
	356	1.14	1.49	0.98	0.92	0.82	2.94	2.26	2.00	0.25	0.58	0.60	0.30	0.11	1.60	16.00
	437	0.19	0.43	0.85	0.51	0.36	2.37	0.47	0.35	0.12	0.01	0.02	0.17	0.04	0.11	6.00
	438	0.01	0.05	0.06	0.06	0.24	0.33	0.05	0.03	0.02	0.02	0.01	0.06	0.37	0.02	1.33
	507	0.61	1.32	0.74	0.69	0.52	2.87	2.69	4.45	0.48	0.38	0.09	0.21	0.07	3.86	19.00
Predicted count		69.36	98.62	75.89	50.23	61.71	242.38	121.00	129.55	19.06	9.45	5.38	16.86	7.96	44.87	
													total observed			952.32
													total predicted			952.32

PSI = .11691
MAX PSI = .8679
% CORR PRED = .2489

TABLE 5-10

PREDICTION SUCCESS TABLE: REDUCED CHOICE SET PERCEIVED MEASURES

		Predicted choice														Observed count
	SITE	337	338	340	342	344	346	348	350	352	354	356	437	438	507	
	337	39.61	15.64	5.35	3.38	0.69	3.07	2.94	1.61	0.96	0.63	0.05	0.16	0.48	2.43	77.00
	338	16.26	22.87	8.75	3.03	0.91	11.16	7.69	5.31	2.49	1.18	0.21	2.86	1.83	2.45	87.00
	340	4.23	10.07	23.15	7.31	5.38	12.89	7.29	2.81	2.26	0.80	0.41	6.81	5.10	1.47	90.00
	342	0.60	3.53	5.16	11.91	24.33	4.90	1.60	1.28	0.86	0.46	0.57	1.85	2.47	2.47	62.00
	344	0.75	0.75	4.19	2.83	6.94	6.56	1.64	4.29	2.34	1.55	0.85	2.36	4.71	4.23	44.00
Observed	346	9.44	14.67	28.84	14.40	7.65	60.74	48.59	24.35	13.38	3.63	1.34	7.02	7.87	12.08	254.00
choice	348	1.01	2.61	2.43	2.01	1.40	9.24	71.22	15.58	4.39	2.10	0.33	1.57	1.32	5.80	121.00
	350	8.86	9.77	4.13	4.57	2.98	13.56	19.00	41.08	6.03	2.37	0.67	1.51	0.94	13.55	129.00
	352	0.85	2.56	2.44	1.12	0.67	4.05	3.58	4.71	2.77	0.40	0.07	0.64	0.45	0.70	25.00
	354	1.54	2.40	1.04	1.05	1.68	1.83	1.19	1.72	1.01	1.62	1.23	3.46	0.36	0.87	21.00
	356	0.33	0.97	0.55	0.92	2.06	0.78	2.55	1.45	0.82	1.01	0.81	3.03	0.19	0.55	16.00
	437	0.29	0.44	1.28	0.56	0.16	0.76	0.29	0.10	0.06	0.01	0.00	1.16	0.86	0.02	6.00
	438	0.00	0.00	0.10	0.01	0.02	0.56	0.01	0.01	0.05	0.02	0.01	0.00	0.11	0.09	1.00
	507	0.14	0.19	0.61	0.41	0.25	2.53	3.91	1.91	0.63	0.67	0.06	0.13	0.10	7.45	19.00
Predicted count		83.91	86.49	88.00	53.53	55.13	132.63	171.47	106.20	38.04	16.45	6.63	32.56	26.78	54.16	
															total observed	951.99
															total predicted	951.99

PSI = .20363
MAX PSI = .89747
% CORR PRED = .3061

APPENDIX 6

TABLE 5-13
PREDICTION SUCCESS TABLE FOR OUT OF SAMPLE PREDICTIONS
FULL CHOICE SET OBJECTIVE MEASURES

		Predicted choice											Observed count
	SITE	337	338	342	344	346	348	350	352	354	438	507	
Observed	337	0.138	0.119	0.046	0.039	0.185	0.181	0.150	0.009	0.001	0.006	0.126	1.000
choice	338	0.033	0.100	0.074	0.071	0.506	0.089	0.069	0.026	0.003	0.010	0.021	1.000
	342	0.196	0.602	0.480	3.031	3.890	0.532	0.403	0.195	0.118	0.430	0.122	10.000
	344	0.105	0.323	0.254	1.386	2.010	0.286	0.217	0.101	0.054	0.197	0.066	5.000
	346	1.843	3.192	1.674	4.471	10.319	4.377	5.331	0.722	0.405	0.634	2.032	35.000
	348	2.134	3.364	1.369	1.349	6.646	5.434	7.620	0.693	0.461	0.191	2.738	32.000
	350	3.060	3.910	1.513	1.443	6.797	6.338	8.111	0.670	0.429	0.205	3.525	36.000
	352	0.862	0.904	0.338	0.308	1.409	1.447	1.612	0.118	0.065	0.044	0.892	8.000
	354	0.075	0.159	0.082	0.367	0.537	0.231	0.324	0.043	0.032	0.052	0.099	2.000
	438	0.138	0.119	0.046	0.039	0.185	0.181	0.150	0.009	0.001	0.006	0.126	1.000
	507	0.505	0.650	0.238	0.229	1.013	1.087	1.447	0.113	0.080	0.033	0.604	6.000
Predicted count		9.090	13.441	6.114	12.734	33.500	20.182	25.434	2.698	1.650	1.807	10.351	

PSI = 0.0481
Max PSI = 0.8530
% CORR PRED = 0.1951

total observed 137
total predicted 137

TABLE 5-14

PREDICTION SUCCESS TABLE FOR OUT OF SAMPLE PREDICTIONS

FULL CHOICE SET PERCEIVED MEASURES

		Predicted choice											Observed count
	SITE	337	338	342	344	346	348	350	352	354	438	507	
	337	0.53	0.08	0.04	0.02	0.11	0.06	0.05	0.06	0.00	0.01	0.06	1.00
	338	0.06	0.15	0.19	0.07	0.21	0.13	0.02	0.07	0.02	0.06	0.01	1.00
	342	0.09	0.02	2.21	1.50	0.41	0.10	0.39	0.60	0.38	3.67	0.64	10.00
	344	0.10	0.27	0.83	0.53	0.79	0.21	0.14	0.33	0.22	1.24	0.34	5.00
Observed	346	1.57	2.14	2.53	2.59	3.25	4.74	4.20	3.85	2.39	1.70	6.03	35.00
choice	348	0.88	1.12	0.67	1.68	4.18	13.33	3.39	0.84	1.00	0.22	4.67	32.00
	350	1.59	1.12	1.71	1.21	3.44	9.83	6.51	2.83	1.46	0.38	5.93	36.00
	352	1.33	0.28	0.25	0.26	0.69	1.57	1.87	0.66	0.18	0.06	0.85	8.00
	354	0.04	0.00	0.08	0.11	0.33	0.57	0.17	0.09	0.11	0.13	0.37	2.00
	438	0.06	0.04	0.03	0.01	0.03	0.46	0.35	0.01	0.00	0.01	0.01	1.00
	507	0.40	0.14	0.26	0.15	0.62	1.53	1.32	0.15	0.17	0.06	1.20	6.00
Predicted count		6.65	5.36	8.80	8.11	14.05	32.53	18.41	9.50	5.93	7.54	20.12	
											total observed		137
											total predicted		137

PSI = 0.0801
Max PSI = 0.8722
% CORR PRED = 0.2078

TABLE 5-15

PREDICTION SUCCESS TABLE FOR OUT OF SAMPLE PREDICTIONS
REDUCED CHOICE SET OBJECTIVE MEASURES

		Predicted choice											Observed count
	SITE	337	338	342	344	346	348	350	352	354	438	507	
Observed	337	0.10	0.12	0.00	0.05	0.22	0.18	0.14	0.02	0.00	0.00	0.16	1.00
choice	338	0.00	0.15	0.00	0.00	0.79	0.00	0.00	0.05	0.00	0.00	0.00	1.00
	342	0.15	0.50	0.91	3.43	3.16	0.48	0.34	0.22	0.13	0.53	0.17	10.00
	344	0.06	0.21	0.58	2.05	1.25	0.20	0.14	0.09	0.04	0.32	0.07	5.00
	346	1.20	2.78	2.20	3.86	11.62	4.17	4.46	1.05	0.52	0.59	2.54	35.00
	348	1.29	2.66	1.99	1.45	7.42	5.39	6.40	0.91	0.59	0.22	3.67	32.00
	350	1.50	2.24	1.76	1.01	6.41	6.32	11.08	0.99	0.52	0.13	4.03	36.00
	352	0.26	0.34	0.06	0.14	1.11	0.99	2.91	0.34	0.10	0.01	0.74	7.00
	354	0.02	0.06	0.07	0.29	0.65	0.29	0.30	0.07	0.05	0.04	0.15	2.00
	438	0.10	0.11	0.07	0.04	0.20	0.17	0.13	0.01	0.00	0.01	0.15	1.00
	507	0.19	0.23	0.14	0.09	1.43	1.30	1.52	0.11	0.04	0.01	0.94	6.00
Predicted count		4.87	9.41	7.76	12.41	34.28	19.50	27.42	3.85	2.00	1.86	12.63	

PSI = 0.0878
Max PSI = 0.8478
% CORR PRED = 0.24

total observed 136
total predicted 136

TABLE 5-16

PREDICTION SUCCESS TABLE FOR OUT OF SAMPLE PREDICTIONS
REDUCED CHOICE SET PERCEIVED MEASURES

		Predicted choice											Observed count
	SITE	337	338	342	344	346	348	350	352	354	438	507	
Observed	337	0.49	0.08	0.00	0.02	0.14	0.07	0.05	0.07	0.00	0.00	0.08	1.00
choice	338	0.00	0.34	0.00	0.00	0.44	0.00	0.00	0.22	0.00	0.00	0.00	1.00
	342	0.08	0.01	1.93	1.22	0.34	0.09	0.41	0.52	0.32	4.49	0.59	10.00
	344	0.12	0.31	1.07	0.68	0.57	0.25	0.13	0.22	0.16	1.34	0.15	5.00
	346	1.41	2.15	2.22	1.97	3.03	5.06	4.30	4.23	2.46	1.50	6.68	35.00
	348	0.90	1.44	0.76	1.13	3.87	14.43	3.31	0.94	1.06	0.23	3.94	32.00
	350	1.07	1.07	1.33	0.88	2.71	9.97	10.02	2.59	1.36	0.22	4.78	36.00
	352	1.02	0.20	0.03	0.12	0.54	1.43	1.95	0.83	0.22	0.01	0.65	7.00
	354	0.07	0.00	0.07	0.12	0.45	0.47	0.17	0.18	0.17	0.15	0.14	2.00
	438	0.06	0.04	0.03	0.01	0.03	0.44	0.36	0.02	0.00	0.01	0.01	1.00
	507	0.34	0.18	0.15	0.08	0.61	1.78	1.32	0.16	0.08	0.06	1.22	6.00
Predicted count		5.56	5.81	7.59	6.22	12.73	33.99	22.00	9.98	5.85	8.01	18.25	

PSI = 0.1090
Max PSI = 0.8652
% CORR PRED = 0.2438

total observed 136.000
total predicted 136.000